BOARD OF AGRICULTURE AND FISHERIES.

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(Nos. 101 to 200).

SECOND EDITION.

WITH INDEX.

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First Edition, Jan., 1909 ... ... *20,000 copies.*
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The Board of Agriculture and Fisheries issue Nos. 1–100 of their leaflets bound together in stiff boards (Price 6*d.*, post free), and the present volume contains the subsequent leaflets, arranged in numerical order, up to No. 200 (Price 6*d.* post free).

The first edition of this volume amounted to 20,000 copies. The present edition has been extensively revised.

The whole series (1–200) has also been grouped under 12 headings comprising certain closely related subjects, and the leaflets in each group may be obtained separately, bound in paper covers, price 1*d.* per copy, post free.

The leaflets will continue to be issued singly, and copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped. The Board hope that those who possess a copy of this volume will make its existence known to all to whom it is likely to be of practical interest.

4, Whitehall Place, London, S.W.,
April, 1911.

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(1.) List of Leaflets arranged in numerical order under subjects.

No.	Title.	No.	Title.
	(1.) *Leaflets relating to Acts of Parliament and Miscellaneous Subjects.*		
177	Precautions against Accidents caused by Farm Machinery.	190	Dogs Act, 1906.
181	Cleansing of Water Courses.	197	Agricultural Education in England and Wales.
189	Insurance of Farming Stock against Fire.		
	(2.) *Leaflets dealing with Farm Animals and Dairying.*		
110	Carriage of Goods by Rail at Owner's Risk Rates.	179	The Making of Soft and Cream Cheeses and Clotted Cream.
121	The Construction of Pigsties.	187	Selection and Milking of Dairy Cattle.
142	Calf Rearing.	191	Cross-breeding for Mutton in the North of England.
146	The Value of Records of the Milk Yield of Cows	192	Farm Butter-making.
151	Cleanliness in the Dairy.		
	(3.) *Leaflets dealing with Diseases and Insect Pests of Farm Animals.*		
101	Prevention of White Scour in Calves.	126	Sheep Maggot Fly.
102	Quarter Ill, Quarter Evil, or Black Leg.	130	Navel Ill and Joint Ill of Lambs.
108	Epizootic Abortion in Cattle.	135	Mange in Cattle.
118	The Sheep Nostril Fly.	145	Sheep Dipping.
119	Sturdy or Gid in Sheep.	154	Foot Rot of Sheep.
	(4.) *Leaflets dealing with Poultry and Bees, their Breeding and Management.*		
111	Co-operative Egg and Poultry Societies.	157	The Sale of Newly-hatched Chickens.
114	The Feeding of Poultry.	167	Duck Raising.
128	Advice to Beginners in Bee-Keeping.	176	Poultry Fattening.
129	Winter Egg Production.	198	Rearing and Marketing of Geese.
141	Preparation of Honey for Market.		
	(5.) *Leaflets dealing with the Cultivation of Fruit Trees and Farm and Garden Crops.*		
112	Weeds and their Suppression.	168	Formation of Permanent Pastures.
134	Apple Culture.	169	Cultivation of Mangolds.
148	Planting Fruit Trees and Bushes.	172	Bare Fallows.
149	Threshing of Barley.	173	Potato Growing.
153	Storing Turnips.	180	Dodder.
160	The Cultivation of Lucerne.	182	Crimson Clover.
162	Grafting Fruit Trees.	184	Red, White, and Alsike Clovers.
166	Some Common Thistles.	194	Coltsfoot.
	(6.) *Leaflets dealing with Manures and Feeding Stuffs.*		
106	Fertilisers for Market Garden Crops.	175	Waste Organic Substances as Manures.
170	The Uses of Lime.	196	Fertilisers and Feeding Stuffs Act, 1906.

No.	Title.	No.	Title.

(7.) *Leaflets dealing with Forest Trees and their Diseases.*

103	Pine Sawfly.	161	Vapourer Moth.
113	Dry Rot.	165	Gall Gnats injurious to Willows and Osiers.
115	Coral Spot Disease.		
138	Pine Weevils.	174	Tree Root-Rot.
140	Felted Beech Coccus.	183	Sycamore Leaf Blotch.
147	Fences and Hedges.	186	Large Larch Sawfly.
155	Larch Canker.	199	A Pine Disease.
156	Hedgerow Timber.		

(9.) *Leaflets dealing with Insect and other Pests injurious to Farm and Garden Crops.*

104	Aphides or Plant-Lice.	132	Slugs and Snails.
109	Cabbage Moth.	136	Bulb or Tulip Mite.
122	Cabbage Root Fly.	143	Turnip Mud Beetle.
124	Asparagus Fly.	150	Pea and Bean Beetles.
125	Hessian Fly.		

(10.) *Leaflets dealing with Insect and other Pests injurious to Fruit Trees and Bushes.*

107	Mussel Scale.	161	Vapourer Moth.
123	Shoot and Fruit Moth of Currants.	188	Fumigation with Hydrocyanic Acid Gas.

(11.) *Leaflets dealing with Fungi injurious to Farm and Garden Crops.*

105	Wart Disease (Black Scab) of Potatoes.	159	Blindness in Barley and Oats.
		163	White Rust of Cabbages.
116	Sleepy Disease of Tomatoes.	164	Potato Leaf-Curl and Black Stripe of Tomatoes.
117	Black-Leg or Potato Stem-Rot.		
127	Sclerotium Disease.	171	Violet Root-Rot.
137	Varieties of Scab in Potatoes.	178	Onion Mildew.
139	Mushroom Disease.	185	Bean Pod Canker.
144	Heart Rot of Beet, Mangold and Swede.	193	Winter Rot of Potatoes.
		200	Black Rot of Cabbages, Turnips, &c.
152	Bacterial Disease of Tomatoes.		

(12.) *Leaflets dealing with Fungi injurious to Fruit and Fruit Trees.*

115	Coral Spot Disease.	158	White Rot of the Vine.
120	Peach Leaf-Curl.	174	Tree Root-Rot.
131	Apple and Pear Scab.	195	American Gooseberry Mildew.
133	Powdery Mildew of the Vine.		

(2.) List of Leaflets in alphabetical order.

Title.	No.	Title.	No.
Accidents caused by Farm Machinery.	177	Fences and Hedges	147
Advice to beginners in Bee-Keeping.	128	Fertilisers for Market Garden Crops.	106
Agricultural Education in England and Wales.	197	Fertilisers and Feeding Stuffs Act, 1906.	196
Alsike Clover	184	Foot Rot of Sheep	154
American Gooseberry Mildew	195	Formation of Permanent Pastures.	168
Aphides or Plant Lice ...	104	Fumigation with Hydrocyanic Acid Gas.	188
Apple Culture	134	Gall Gnats injurious to Willows and Osiers.	165
Apple and Pear Scab	131	Gid in Sheep	119
Asparagus Fly	124	Gooseberry Mildew, American	195
Bacterial Disease of Tomatoes	152	Grafting Fruit Trees ...	162
Bare Fallows	172	Heart Rot of Beet, Mangold, and Swede.	144
Bean Pod Canker	185	Hedgerow Timber	156
Bean and Pea Beetles	150	Hedges and Fences	147
Black-Leg or Potato Stem-Rot	117	Hessian Fly	125
Black Leg	102	Hydrocyanic Acid Gas, fumigation with.	188
Black Rot of Cabbages, Turnips, &c.	200	Insurance of Farming Stock against Fire.	189
Black Scab of Potatoes ...	105	Larch Canker	155
Black Stripe of Tomatoes ...	164	Large Larch Sawfly	186
Blindness in Barley and Oats	159	Lime, Uses of	170
Bulb or Tulip Mite	136	Making of Soft and Cream Cheeses and Clotted Cream.	179
Cabbage Moth	109	Mange in Cattle	135
Cabbage Root Fly	122	Market Garden Crops, Fertilisers for.	106
Calf Rearing	142	Marketing of Geese	198
Carriage of Goods by Rail at Owner's Risk Rates.	110	Milking of Dairy Cattle ...	187
Cleanliness in the Dairy ...	151	Mushroom Disease	139
Cleansing of Water Courses ...	181	Mussel Scale	107
Coltsfoot	194	Navel Ill and Joint Ill of Lambs.	130
Coral Spot Disease	115	Newly-hatched Chickens ...	157
Construction of Pigsties ...	121	Onion Mildew	178
Co-operative Egg and Poultry Societies.	111	Pea and Bean Beetles ...	150
Crimson Clover	182	Peach Leaf-Curl	120
Cross-breeding for Mutton in the North of England.	191	Pear Scab	131
Cultivation of Lucerne ...	160	Permanent Pastures, Formation of.	168
Cultivation of Mangolds ...	169	Pigsties, Construction of ...	121
"Day-old" Chickens	157	Pine Disease	199
Dodder	180	Pine Sawfly	103
Dogs Act, 1906	190	Pine Weevils	138
Dry Rot	113	Plant Lice or Aphides ...	104
Duck-Breeding	167	Planting Fruit Trees and Bushes.	148
Ducks and Duck-Breeding ...	167	Potato Growing	173
Egg and Poultry Societies ...	111	Potato Leaf-Curl and Black Stripe of Tomatoes.	164
Epizootic Abortion in Cattle	108		
Felted Beech Coccus	140		
Farm Butter-making	192		
Feeding of Poultry	114		
Feeding Stuffs and Fertilisers Act, 1906.	196		

(2.) List of Leaflets in alphabetical order.—*cont.*

Title.	No.	Title.	No.
Potato Stem-Rot	117	Some Common Thistles ...	166
Poultry Fattening	176	Storing Turnips	153
Poultry Societies	111	Sturdy or Gid in Sheep ...	119
Powdery Mildew of the Vine	133	Sycamore Leaf Blotch ...	183
Precautions against Accidents caused by Farm Machinery.	177	Threshing of Barley	149
		Tree Root-Rot	174
Preparation of Honey for Market.	141	Tulip Mite	136
		Turnip Mud Beetle	143
Prevention of White Scour in Calves.	101	Uses of Lime	170
		Value of Records of Milk Yield of Cows.	146
Quarter Ill, Quarter Evil, or Black Leg.	102		
		Vapourer Moth	161
Rearing and Marketing of Geese.	198	Varieties of Scab in Potatoes	137
		Violet Root-Rot	171
Red, White, and Alsike Clovers	184	Wart Disease of Potatoes ...	105
Sale of newly-hatched Chickens	157	Waste Organic Substances as Manures.	175
Sclerotium Disease	127		
Selection and Milking of Dairy Cattle.	187	Water Courses, Cleansing of	181
		Weeds and their Suppression	112
Sheep Dipping	145	White Clover	184
Sheep Maggot Fly	126	White Rot of the Vine ...	158
Sheep Nostril Fly	118	White Rust of Cabbages ...	163
Shoot and Fruit Moth of Currents.	123	White Scour in Calves, Prevention of.	101
Sleepy Disease of Tomatoes ...	116	Winter Egg Production ...	129
Slugs and Snails	132	Winter Rot of Potatoes ...	193
Soft Cheese Making	179		

BOARD OF AGRICULTURE AND FISHERIES.

Prevention of White Scour in Calves.

In order successfully to combat the disease known as White Scour in calves, a disease which yearly claims a large number of victims, the following procedure should be fully and carefully attended to :—

Disinfection of Premises.

The floors of cow-houses and calf-houses should be thoroughly cleaned and disinfected at least once each week with a solution of blue-stone (*Copper sulphate*), made by adding 2 lb. of blue-stone to 3 gallons of water. The floor of the calf-house should be of concrete, and should be swept daily and disinfected with a solution of blue-stone of the above strength.

Navel Treatment.

(*a.*) When a cow is about to calve she should be given a good bed of clean fresh straw to keep the calf clean.

(*b.*) When she shows signs of calving her "bearings" should be washed with a warm 2 per cent. solution of Lysol in rainwater. The same warm solution of Lysol should be injected into the passage through which the calf is to be born.

(*c.*) Immediately the calf is born the navel cord should be tied with twine which must be kept ready in a solution of Lysol. The person who ties the cord should first scrub and wash his hands in a solution of Lysol.

(*d.*) Immediately the cord is tied the portion adhering to the calf, as well as the surrounding part of its body, should be carefully painted with a solution of iodine in methylated spirits (35 grains of iodine to 2 pints of methylated spirits).

(*e.*) After a few minutes the navel cord should be painted with a layer of collodion containing 1 per cent. of iodine, or with Stockholm tar.

General Recommendations.

1.—Navel treatment without repeated and careful disinfection will NOT be successful.

2.—Newly-born calves should be placed in a spot which has been freshly disinfected. Carbolised sawdust will be found a useful litter.

3.—Healthy calves should not be housed or fed with those that are diseased.

4.—Separated milk should not be given until the calf is four weeks old. The change from new to separated milk should be gradual. The calf should have a substitute for the cream removed by the separator. One to two oz. per day of the best cod liver oil, or a mucilage prepared by steeping linseed or good linseed cake in hot water, will be found useful for this purpose. The quantity, however, should be carefully regulated in accordance with the state of the bowels.

For further hints on the treatment of calves reference should be made to Leaflet No. 142 on Calf Rearing.

4, Whitehall Place, London, S.W.,
March, 1904.

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Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W.

A pamphlet containing 20 leaflets dealing with the diseases and Insect Pests of Farm Animals can be obtained from the same address, price 1d., post free.

BOARD OF AGRICULTURE AND FISHERIES.

Quarter Ill, Quarter Evil, or Black Leg.

Although quarter ill has existed in Great Britain and in Ireland for a very great number of years, no reliable estimate can be formed of the number of animals which annually die of this disease; but it may at least be concluded that the mortality is very serious.

Quarter ill may be said to lack much of the importance and interest which is attached to anthrax, inasmuch as it is confined to two domestic animals—sheep and cattle—and is not communicable to man. It, however, resembles anthrax, in so far as they are both caused by the introduction of specific bacilli into the system of the healthy animal.

Both diseases have a tendency to recur on farms or premises on, or in, which animals affected with these diseases have been previously kept.

On the other hand neither anthrax nor quarter ill is communicable by direct association of the affected with the healthy animal, and in that respect they differ from most of the contagious diseases which are legislated for in this country.

Another peculiar feature of quarter ill is that cattle over two years old may be said to have a high degree of immunity against the disease.

Symptoms.—The symptoms of quarter ill in young cattle are so strikingly different from any other disease that an error in diagnosis is almost impossible. The first indication of an animal being affected with quarter ill is a marked stiffness or lameness of one of the limbs; it is exceedingly dull, and presents a most anxious and dejected appearance, does not feed, and it is with extreme difficulty that it can be forced to move. Very soon after the limb is attacked a swelling appears beneath the skin, usually upon one of the hind quarters. This swelling, which is extremely hot, increases in size rapidly, and is most painful when touched. It also has a disposition to extend down the leg, or perhaps along the loins and back, and when pressed gives a peculiar crackling sensation to the fingers. In almost every instance death supervenes within a few hours after the swelling has appeared.

In the case of sheep the symptoms are not of so marked a character. The first indication is lameness, but the swelling is not so observable in sheep as in cattle.

There is no doubt that the disease exists to a greater extent among the sheep in certain counties in England than reports generally show, and from the rapidity with which sheep frequently die it is often locally called "strike."

Should any doubt exist in the mind of an owner as to whether his sheep have died from quarter ill, he should make an incision into the affected part of the dead animal, when he will often find that the muscular tissue is very dark red in colour and exudes a quantity of dark bloody fluid. Any fluid that may thus escape should be carefully collected and destroyed. The organism causing the disease, like that of anthrax, is believed to exist in the soil. It has not yet, however, been determined how it finds its way into the system of the affected animals, but the probabilities are that it is through the digestive system.

Treatment.—(1) No form of medical treatment has been discovered which can be relied upon as a cure for quarter evil, but it has been claimed by veterinarians residing on the continent of Europe and in America, in which countries the disease appears to be more prevalent than it is in Great Britain, that certain vaccines which have been prepared from the organism of quarter evil give protection to the animals inoculated. Some of the authorities regard one vaccination as sufficient, while others advocate a second after an interval of eight days, but the period for which immunity can thus be obtained has not yet been satisfactorily determined. Another most important fact, which must not be overlooked, is that sometimes the inoculation is followed by the death of the animal which it was intended to protect.

(2) Since quarter ill and anthrax are both due to specific bacilli which, although different in form, have equally fatal results, similar steps in the mode of disinfection should be adopted. There is little hope that any attempt to destroy the spores of the disease in the soil can be followed by any good result, but measures of a preventive nature can be adopted by everyone who has the misfortune to have the disease in his sheds, yards, or other enclosed places.

(3) The carcases of animals which have died of quarter ill should be buried in accordance with the rules laid down for anthrax (Leaflet No. 28), or, still better, cremated on or in the place where the animal died.

(4) All dung, fodder, litter, or other materials of a like character which may have been on or about places or sheds where animals have died should be burnt, or thoroughly mixed with some powerful disinfectant and buried in a part of the premises to which cattle and sheep do not have access. The sheds, particularly the flooring and mangers, should be thoroughly washed and scrubbed with a 5 per cent. solution of carbolic acid, and it would be prudent to repeat the process before they are again used for cattle or sheep.

4, Whitehall Place, London, S.W.,
February, 1904.
Revised, April, 1903.

BOARD OF AGRICULTURE AND FISHERIES.

The Pine Sawfly (*Lophyrus pini*).

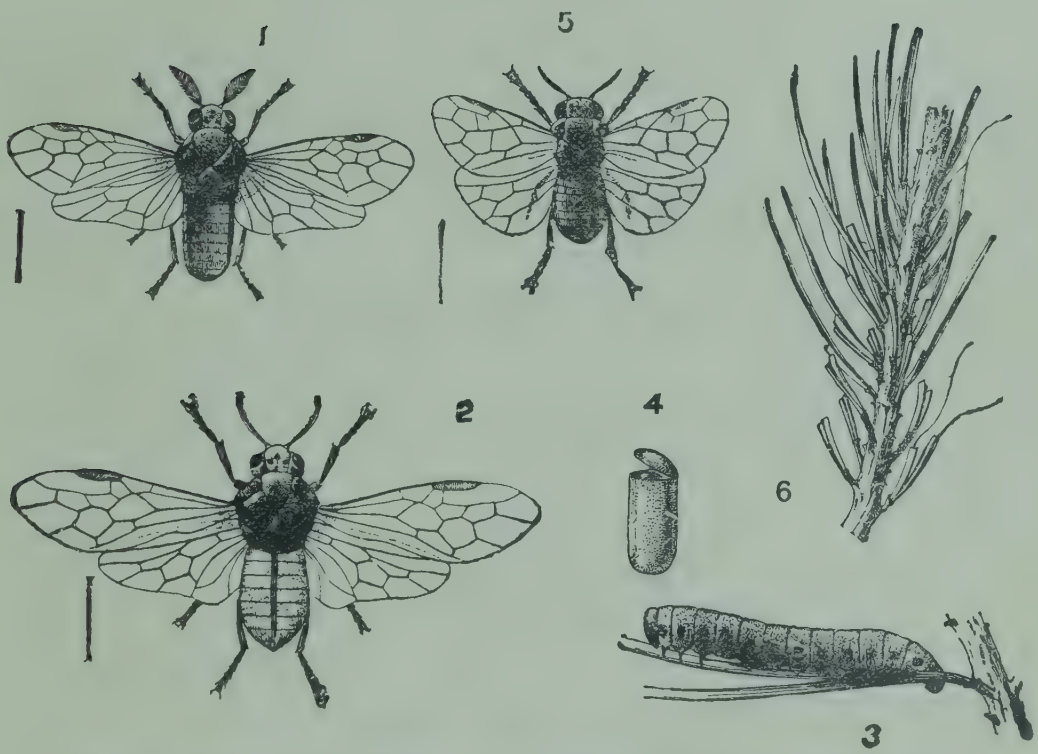

Fig. 1, *Lophyrus pini*, Male; Fig. 2, Female; Fig. 3, Larva; Fig. 4, Cocoon; Fig. 5, *Lophyrus rufus;* Fig. 6, Pine shoot attacked by Sawfly larvæ. Lines show natural size of Figs. 1, 2, and 5.

Young Pine trees, especially the Scots Pine and Black Austrian Pine, are frequently seriously damaged by the larvæ of sawflies. The chief culprit is the Pine Sawfly (*Lophyrus pini*), but *Lophyrus rufus* may, in Pine plantations, be very destructive.

The Pine Sawfly prefers trees with a sunny aspect, and hence it will be noticed in greatest abundance at the borders of plantations or around clearings. Trees from ten to thirty years old are subject to the ravages of this pest, but younger and older trees may sometimes be seen severely attacked. The damage they do is soon noticeable owing to the larvæ feeding in companies; these colonies number sometimes as many as a hundred individuals, but

as the larvæ grow they disperse. The harm done is two-fold ; the needles are eaten, and the bark of the shoots bearing these needles is also gnawed away. The young caterpillars eat the needles from the side, the midrib being left hanging. Older caterpillars eat the complete needles right down, or almost right down, to the dwarf shoot. Another sign of attack is the characteristic greenish excrement lying below the food plant. There may be two broods during the year.

This forest pest often attacks large areas at the same time. In one instance 2,000 acres were invaded. The caterpillars are not hardy, and may disappear suddenly, as they are susceptible to climatic changes, cold and wet weather being very prejudicial to them.

Description.

The adult L. pini is nearly three-fifths of an inch across the wings in the male (Fig. 1), and about four-fifths in the female (Fig. 2). The male is black, with the apex of the abdomen reddish ; and with white spots on the underside of the first segment ; in the female the body is dull yellow, with three dark areas on the thorax, and the middle of the abdomen black ; the legs are yellow and the wings have dusky borders, which are, however, not so noticeable in the fore wings of the male. The sexes can most easily be distinguished by the male having doubly pectinate antennæ, those of the female being bristle-like.

The *larvæ* are nearly an inch long when full fed, and, like all the larvæ of this genus, they have twenty-two legs. They are at first pale green, almost whitish beneath, and with black sucker feet, but as they mature they become dull brownish-green with dusky marks above the prolegs, and with a dark brown head ; the sucker feet are yellow with a brown line at the base.

The *cocoons* are very variable in colour, some being quite dark, others dull brownish-grey ; they are about a quarter of an inch long, rounded at the ends, and hard and compact.

Life History.

The *adult sawflies* may appear at the end of April or in May and the beginning of June. The female is sluggish and seldom flies. She lays her eggs in the needles in slits cut by the saw-like processes common to the sawflies. As many as ten to twenty may be placed on each needle, but a smaller number is common. The eggs are usually laid in close proximity, each one being covered over with a resinous secretion and so protected from various enemies.

The *larvæ* hatch in from two to three weeks, appearing at the end of May and in June. They are full-fed by or in July when pupation may take place, a second generation of

sawflies issuing in July and the beginning of August. The eggs from these hatch out caterpillars which feed on until the autumn, when they make a cocoon under cover of which they lie until the next spring, when pupation takes place—the adults issuing in April or May. Or there may be only one generation in the year, the caterpillars full-grown in July lying sheltered in their cocoons until the following spring, when they pupate.

There is much overlapping however among individuals of different broods, and even of the same brood. Some caterpillars taken in August made cocoons from August 14–17, and the first adults issued on April 27th. The cocoons of those which spin up in summer are attached to bark and needles; the winter cocoons are in the soil.

The adult issues by an opening with a lid at one end of the cocoon (Fig. 4).

The Fox-Coloured Sawfly (*Lophyrus rufus*).

The male is glossy black, with the first abdominal ring and the feet (except the claws) red. The larger female is reddish-brown in colour, with black spots on the thorax, and yellow to reddish-brown legs.

It occurs on the wing in August and September. One brood only appears to exist, and is found in larval form from the end of May until the middle or end of June. The larva has a black head and is dusky greenish-grey in colour; a pale line runs along the back, and a dusky line with a pale one on each side of it above and below; the spiracles are placed on the lower pale line. The sucker feet and under side of the body are pale green. When full grown the larvæ are rather more than half an inch in length, and then form oval, pale yellowish-brown, parchment-like cocoons, both amongst the needles and amongst heather, and in the earth, &c., beneath the trees. Like the common Pine Sawfly the caterpillars also are met with in colonies, two individuals usually sitting on each needle. They pupate in June, some specimens kept under observation going into this stage in the third week in June. Although needles and other "cover" lay on the ground in the breeding cage, they pupated in the earth just as described by Kollar. The females which come from such cocoons lay their eggs in August and September in the needles as is done by *L. pini*. Other caterpillars fed in captivity made their cocoons in July. The first adults issued from these on August 24th, and adults continued to issue during the first half of September. Apparently the eggs remain in the needles all the winter and hatch out in early May.

Preventive and Remedial Measures.

(1.)—It does not appear certain that sickly trees are more attacked than healthy ones, but in any case attention should

be given to maintaining plantations in robust growth. All the Pine Sawflies have many enemies. Amongst these may be mentioned the cuckoo, goat-sucker, and starling, which devour numbers of the larvæ and adults. Numerous Ichneumon flies also prey upon them.

(2.)—When young trees are invaded, the larvæ may be easily destroyed by crushing them with a gloved hand. This should be attempted in the early stage of an attack, as at that time the larvæ are present in fairly compact groups, and are readily dealt with.

(3.)—Shaking the larvæ from the trees on to cloths spread on the ground is recommended, but is a less satisfactory method of destruction than the other.

(4.)—Another plan is to place fresh pine boughs beneath the trees and then jar the larvæ off. All those that fall to the ground collect on the boughs strewn about, and can then easily be burnt.

(5.)—Trees that have been attacked may have the ground around their trunks examined in winter, when the dead leaves, moss, etc., containing the cocoons may be raked together and destroyed.

(6.)—Ornamental trees in parks and gardens may be speedily cleared by spraying with hellebore wash or arsenate of lead.

4, Whitehall Place, London, S.W.,
March, 1904.

Revised, June, 1905.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Aphides or Plant-Lice.*

Nearly all plants, both in garden and field, and under glass, suffer from the ravages of Aphides. These universal pests are most common in temperate climates, but even in the tropics whole crops are ruined by them. Aphides are known by a variety of common names, such as Plant-Lice, Green or Black Fly, Smotherers, and Dolphins, while the disease they cause is sometimes termed "Blight."

Aphides are soft-skinned insects with antennæ generally longer than the body. When wings are present they are delicate, and have few veins. On the upper surface of the abdomen two tubes are generally present—sometimes short, sometimes long—from which a liquid can be discharged. The mouth parts are fitted for piercing and sucking; the plant tissues are first pierced and then the sap is drawn away. The skin of plant-lice is provided with glands which secrete a waxy or mealy substance or woolly masses which have the power of throwing off water.

The young differ little in form from the full-grown insects, and their feeding habits are the same.

Development from the young stage to adult takes a very short time, and hence multiplication of individuals is rapid. Dry, hot weather is specially favourable for Aphides.

The summer generations of Aphides are produced without the presence of males, and the females may be wingless or winged, both conditions being found in the same life-history. The winged generations spread the infestation. These females—wingless and winged alike—can give rise to live young, and this power of viviparous multiplication and the appearance of winged forms are to be associated with abundance of food at certain times of the year. As the cold part of the year comes, males as well as females are produced and fertilised eggs are laid.

Some Aphides confine themselves to one species of plant; others migrate so that part of the life-cycle is spent on a plant of a different species. Migration of the same kind of Aphid may take place to a number of quite unrelated species of plants.

Aphides damage plants in two ways; (1) by sucking away the sap and so weakening the plant, and (2) by their excrement falling on the leaves and clogging the stomata and so interfering with gaseous interchange. Further, the excrement, consisting partly of a sweet gummy substance called "honeydew," is a favourable germinating medium for the spores of some fungi, and spoiled sooty-coloured patches show on twig, leaf, and fruit.

* The following species of Aphis are dealt with separately, viz.: Woolly Aphis (Leaflet 34), Currant Aphides (Leaflet 68), and Hop Aphis (Leaflet 88).

Natural Checks.—Several insects prey upon Aphides, and should be encouraged. The chief of these are Ladybirds and their larvæ (*Coccinellidæ*); Hover-fly larvæ (*Syrphidæ*); and the larvæ of the Lace-wing Flies (*Chrysopidæ*). Various minute Hymenopterous parasites (*Chalcididæ*) lay their eggs in the bodies of Aphides, those parasitised being destroyed. Man cannot, however, rely solely on the services of these beneficial insects, but should check the increase of the Aphides by washes as soon as they appear upon his plants.

The Bean Aphis (*Aphis rumicis*, Linn.).

The Bean Aphis, known variously as Black Fly, Collier, and Black Dolphin, is in some years a very severe enemy of the bean crop, shoots and pods being quite smothered with the insects. Harm results not only from the weakening of the plant by the draining away of the sap, but also from the masses of excrement which cover and clog the outside of the plant. Important points in the biology of this Aphis are: (1) It does not confine itself to the bean crop, but is found on many other plants in widely separated Natural Orders, examples being docks, thistles, furze; (2) There are regular migrations to these plants and back to the bean again; and (3) Various generations with somewhat dissimilar individuals are found at different stages in the life-history. The following are recognisable:—(*a*) The early wingless female, on the bean, black in colour with ochreous tints on the shanks and the middle joints of the antennæ. This female produces live young; the young are slate-grey to black. At certain times a stage is found when the insects show dusky wing-cases or wing rudiments, and the abdomen is black, with white spots; this is the stage preceding (*b*) the winged females. These winged females are black or black with a brownish tinge; the shanks and middle joints of the antennæ are yellowish; the wings are yellow at the base, greenish in front, and have brown veins. These females produce live young. (*c*) Wingless females found in autumn and resembling the females of (*a*); the females of (*c*) lay eggs. (*d*) Males, appearing late in the season; they have wings, and are black or black-brown in colour.

Life-History.—The wingless females of the early part of the year are found on the bean tops, and give rise to live young. Multiplication is rapid, and ultimately winged females appear which spread the infestation to other beans and to different food plants. In the autumn, with the appearance of the males and egg-laying females, fertilised eggs are laid on the plants to which the Aphides have migrated.

Treatment.—(1) The infested tops should be cut off and burnt. This should be done early. (2) The beans should be sprayed with soft-soap and quassia. Dissolve 5 lb. of soft-soap in 100 gallons of soft water; boil 6 to 8 lb. of quassia chips in water, and add the extract to the 100 gallons of wash.

The Cabbage Aphis (*Aphis brassicæ*, Linn.).

In the case of this species, infested leaves drained of their sap become yellow and bleached. Blistered patches show, and under these the Aphides are found. As the numbers increase the pests are found both on the upper and lower surfaces of the leaves.

The wingless viviparous females have their bodies covered with a mealy secretion that gives them a white appearance and masks the grey-green colour of the body; dark spots are present on the upper surface; the antennæ are green or yellow-green with dark tips; legs and eyes are dark-brown or brown-black; the cornicles or tubes on the back are short and dark-brown; the young, until the mealy secretion appears, are bright yellow or yellow-green.

When the mealy secretion is removed the winged viviparous females are seen to have the front part of the body black, and the hind part yellow-green; legs and cornicles are dark-brown.

The males are green with black antennæ, and the cornicles are dark at the base.

The egg-laying female is green, with rows of dark spots on the back; the eggs are green at first, but later are black.

Life-History.—Young Aphides hatch from eggs laid in the previous autumn on cruciferous plants (both wild and cultivated). During the summer the wingless and winged virgin females are found. The winged females spread the infection. Both the wingless and the winged females produce live young. Towards the end of the season, when infestation is worst, males and wingless egg-laying females pair, and fertilised eggs are laid from which in the next year come the individuals which start the colonies for the year.

Treatment.—(1) Cruciferous weeds should be kept down as ar as possible. (2) The insects should be attacked early with soap and water, and the watering should be repeated.

On large areas, as in field cultivation, no treatment will avail when widespread attack has been neglected.

Rose Aphides.

Different species of the genus *Siphonophora* are found on roses. One of these, *S. rosæ*, migrates to teasel and returns later in the year.

Treatment.—Spraying should be done with the soft-soap and quassia spray (p. 2), but only 4 lb. of soap should be used. Spraying should be carried out twice in the same week.

The Plum Aphis (*Aphis pruni*, Reaumur).

The Plum Aphis is a serious pest on plum, damson, and allied Rosaceous fruit trees. The loss of sap due to its feeding causes the leaves to curl and discolour, and the young fruits fall off.

The eggs found in autumn and winter are shining black. The young from the eggs are green or dark green; they develop into wingless viviparous females, which vary in colour from green to olive-brown. The pupal stage or stage preceding the winged viviparous female is characterised by rudiments of wings or wing-cases; the body is green and the wing-parts brownish. The winged viviparous female is apple-green, with the antennæ, head, upper surface of thorax, and the feet, black.

Of the sexual individuals, the males are small; they have wings and are yellow-brown or black in colour; egg-laying females are small and wingless; they are greenish-yellow in colour and transparent.

Life History.—Fertilized eggs are laid in the autumn on the twigs and at the base of the buds. The winter is passed in the egg stage. Hatching takes place in spring, the young from the eggs developing into adult females, which are wingless and give rise to live young. These in turn become adult wingless viviparous females. As the season advances some of the young, instead of developing as stated, show wing rudiments and develop into winged viviparous females. These may spread the infection. Late in the year males and wingless egg-laying females are found and fertilized eggs are laid, which remain unhatched over the winter.

Treatment.—(1) Spraying should take place with soft-soap and quassia wash, or with paraffin emulsion, early in the year, when the young Aphides are noticed to have hatched out. The spray should always be applied before the leaves have curled. (2) Spraying should also be done in the autumn with paraffin emulsion, in order to kill the egg-laying females, *e.g.*, late in September or during October. (3) Theobald writes favourably of a late winter wash, where the pest is abundant, the plums and damsons to be heavily sprayed with lime-wash, salt, and water-glass *just before* the bursting of the buds. This wash is said to prevent the hatching of eggs; the formula given is 1 cwt. lime, 30 lb. salt, and 5 lb. water-glass to 100 gallons of water.

Another Aphid found on plums and allied fruit plants is *Hyalopterus pruni*, Fab. As a spray against this Aphid, which is found on the under surface of the leaves, Theobald quotes a correspondent's treatment as very satisfactory, viz., paraffin emulsion, with 1 lb. of liver of sulphur added for every 100 gallons of the wash.

A third Aphid which in certain stages of its life-history is found on the genus *Prunus* is *Phorodon humuli*, described in Leaflet 88. This species is distinguished from the others by two marked projections from the forehead, between the antennæ.

4, Whitehall Place, London, S.W.
June, 1904.
Re-written, January, 1911.

BOARD OF AGRICULTURE AND FISHERIES.

Wart Disease (Black Scab) of Potatoes.

(*Synchytrium endobioticum* Percival.*)

The disease known as Wart Disease, Cauliflower Disease, Canker, "Fungus" or Black Scab, attacks the tubers and haulms of potatoes, giving rise to large and irregular outgrowths which suggest a resemblance to pieces of cauliflower. In bad cases these "warts" may appear at the surface of the soil and can be detected at the base of the haulm as yellowish-green masses (Fig. 1).

Warts or wrinkles appear at first in the eyes of the young tuber (Fig. 2), and later several warts by growing together form a brown spongy scab, which finally rots and becomes black (Figs. 3 & 4). This scab has no connection with ordinary potato scab and does not resemble it in appearance, but as both are frequently found on the same plant they are sometimes confused.

The disease has caused most damage in gardens or allotments where potatoes are grown every year, but in a few cases there has also been serious loss in potatoes grown on farms worked on a four-course rotation.

The occurrence of the wart disease in the affected districts is similar to that of the Finger-and-toe disease (Leaflet No. 77) which, on certain soils and in some seasons, causes serious damage to turnips. Though in the first instance only a few plants may show the wart disease, it is almost sure to spread, and the disease must be treated as a dangerous enemy, which, if neglected, may entirely prevent the profitable culture of potatoes where it occurs. Land may be unfit for potato-growing for as long as six years after infection, and possibly for a much longer period.

Cause of Infection.

The diseased tubers or haulms contain numberless "spores" (the "seeds" of the disease) which are not only capable of infecting healthy potatoes the following season, but appear to be able to lie dormant in the soil for several years.

The diseased tuber is the usual source of infection and the spread of the disease from one holding to another is mainly to be attributed to the planting of infected sets.

When disease appears it may, if neglected, spread over a farm and render the soil useless for potato growing in the course of a few years. It is spread by manure, by the decay

* Hitherto the fungus causing Wart Disease has been known as *Chrysophlyctis endobiotica.*

of affected haulms, tubers and runners in the soil, and it may even be carried from one field to another on implements and boots.

Diseased potatoes must always be well boiled before being given to cattle or pigs, for infection is very readily spread by manure if raw diseased tubers are fed to stock. For the same reason diseased haulms must be burned and never be thrown on the manure heap; this should be done as soon as possible after the crop is lifted, as the "warts" rot very quickly and further contaminate the soil. Dung which has been contaminated in any way should not be used for potato growing. If practicable, it should be applied to land under permanent grass.

Preventive and Remedial Measures.

1.—"Seed" potatoes from a diseased crop or from a field in which disease is known to have occurred within six years should be avoided. If "seed" potatoes are purchased in a district in which the disease is common, they should be bought as soon after harvest as possible, so that they may be kept under observation; the sets should be freely sprinkled with sulphur (4–5 lb. will dress a ton) and should then be stored in boxes or pits until required.

Tubers only slightly diseased may be easily overlooked, and may cause widespread infection when planted. Potatoes from an infected crop may appear to be perfectly sound when lifted, but after storing they may develop warts. It is important, therefore, that seed should be carefully examined before planting. As minute warts are difficult to see a grower would be well advised to reject any seed potatoes among which diseased tubers have been found.

2.—In the case of a disease like wart disease, which infects the land gradually, it is necessary to detect and stamp out the fungus as soon after infection as possible. When discovered the entire plant affected should be carefully removed, the useless portions burned, and the tubers boiled without delay. If possible the surrounding soil should also be removed and burned, or at least heavily dressed with gas-lime. Further, when the field is next planted with potatoes the piece of ground where the disease appeared should be fallowed and dressed with gas-lime at the rate of 4–5 tons per acre.

If the attack has occurred in a garden required for frequent potato growing, the occupier should dig out and burn, not only the affected plant, but a considerable quantity of the surrounding soil so as to ensure that every fragment of the diseased plant is destroyed. Gas-lime should then be applied to the soil.

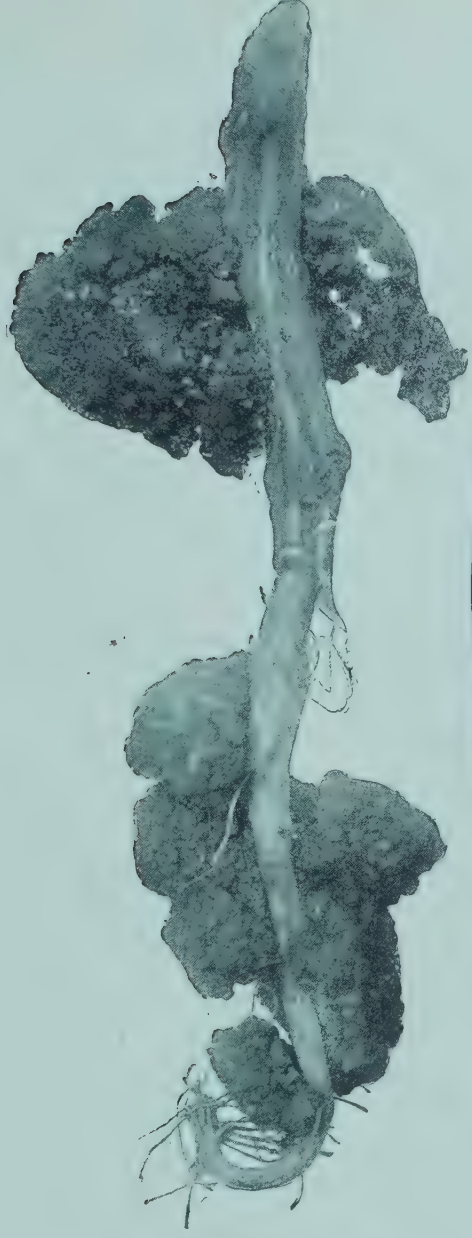

Fig. 1.

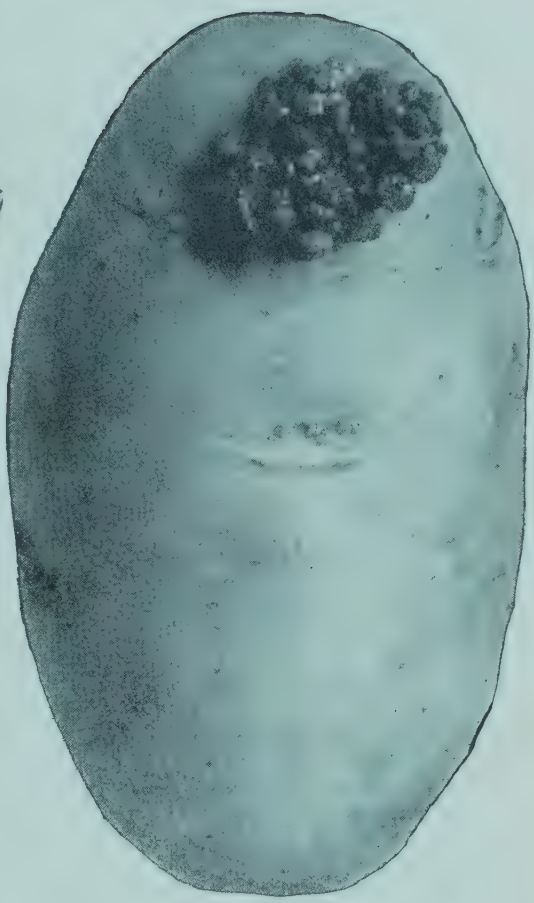

Fig. 2.

Fig. 3.

WART DISEASE OF POTATOES.

Fig. 1. Affected stem. Fig. 2. Tuber slightly attacked (the minute black dots are the sclerotia of Violet Root-Rot, *Rhizoctonia Violacea*—Leaflet No. 171). Fig. 3. Tuber badly attacked.

3.—If fields worked on the four-course rotation have become generally infected, farmers should replace the potato by some other crop, so as to let eight years intervene before the next potato crop is planted. The sets should be dusted with sulphur before planting, as recommended above.

4.—In gardens and allotments in which the disease has appeared, potatoes should on no account be planted on the same piece of land next season, and one of the following methods of treatment may be adopted :—

(*a.*) The ground, towards the end of April, should be covered with gas-lime (2 lb. to the square yard) which may be forked into the surface soil to a depth of 3 inches. After lying fallow until the end of June it should be dug and prepared for cabbages.

(*b.*) If the soil be deep, 2 lb. of gas-lime per square yard may be applied at the end of March, and a month later the soil should be inverted by deep trenching. Any crop except potatoes may be grown.

In gardens in which even a single diseased potato has been found the course recommended in the foregoing paragraphs should be adopted ; but if no other land for growing potatoes is procurable, and occupiers of gardens and allotments are obliged to grow potatoes on land on which disease has been seen, they should apply gas-lime in autumn or early winter at the rate of 3 lb. to the square yard. After the sets have been placed in the drills they should be freely sprinkled with sulphur. Before the plants are "earthed up" the ground should again be sprinkled with sulphur.

Sulphur suitable for the purposes indicated above should be procurable at from 9*s.* to 11*s.* per cwt., or 1*s.* 3*d.* to 1*s.* 6*d.* per stone. Sulphur is recommended because, of many remedies tried for dressing soil during the growing season, it seems to be the best. It sometimes does good, especially in light soils, but it cannot be relied upon to protect potatoes planted in badly-affected soils.

Potatoes differ widely in their susceptibility to wart disease. The following are free, or practically free, from attack :—"Langworthy," "What's Wanted," "Golden Wonder," "Peacemaker," "Sutton's Discovery." The following are usually free from wart disease, but may be attacked on very badly infected soil :—"Aberlady Early," "Milecross Early," "Snowdrop," "Southern Queen," "Southern Star," "Findlay's Conquest," "Sutton's Abundance," "Sutton's Supreme," "Sutton's White City," "Chiswick Favourite," "Dobbie's Favourite," "The Crofter," "The Provost," "Davie's Laird," "Schoolmaster." In addition to the above which have been tested by the Board, "St. Malo Kidney" has been reported to them to be free from wart disease. The following varieties all contract wart disease badly when grown on infected soils:—"Puritan," "Sharpe's Victor," "Express," "Epicure," "Myatt's Ashleaf," "May Queen," "Midlothian Early," "Ninetyfold," "Mairsland Queen," "Royal Kidney," "British Queen," "Radium," "Russet Queen," "Colleen,"

"Lady Llewellyn," "Sutton's Harbinger," "Sutton's Centenary," "Sutton's Satisfaction," "Windsor Castle," "Northern Star," "Eldorado," "Talisman," "President," "Tyne Kidney," "The Scot," "The Bruce," "King Edward VII." and "Up-to-Date" or similar varieties, as "Factor," "Table Talk" and "Duchess of Cornwall."

For early use, "Snowdrop," "Conquest," or "Abundance" may be recommended. The two latter are prolific varieties of good quality, but in wet seasons very liable to ordinary potato disease. They should be sprayed with Bordeaux mixture while growing (*see* Leaflet No. 23). For late use "The Provost," "Davie's Laird," "Golden Wonder" and "Langworthy" may be recommended. If the soil is badly infected preference should be given to the two last named.

Fig. 4.—Tuber badly attacked by Wart Disease and commencing to decompose.

"Langworthy" is commonly cultivated in the potato-growing districts of the East of Scotland, and reliable seed is easily procurable. It does not yield so heavily as "Up-to-Date," but is less liable to ordinary potato disease,

and the cooking quality is much better, so that even in districts where wart disease has not appeared it is a variety to be recommended. It requires rather a long period of growth, well-tilled soil, and a free use of manure. Those who wish to grow it successfully should give attention to the following points :—

(1) Cultivate the land deeply : shallow soils should be subsoiled, or in the case of gardens trenched to a depth of 15 inches.

(2) Apply dung liberally : in the case of fields 15 to 20 tons per acre, and supplement this dressing with a mixed artificial manure (*see* Leaflet No. 80, *Use of Artificial Manures*).

(3) Avoid using very small "seed," sprout the tubers before planting, and plant early.

N.B.—Wart Disease (*Synchytrium endobioticum*) is scheduled as a notifiable disease under the Destructive Insects and Pests Acts, 1877 and 1907, and occupiers of land on which the disease occurs must at once report it to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W., or in certain counties to the police. In reporting an outbreak, occupiers must state their names in full and their postal address, and it is desirable that specimens for identification should be sent to the Board. Neglect to report renders the owner liable to a penalty not exceeding £10 (ten pounds). This regulation applies to all growers, including those who grow for private use only.

4, Whitehall Place, London, S.W.

April, 1904.

Revised, December, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 20 leaflets dealing with Fungi injurious to Farm and Garden Crops may be obtained from the same address, price 1d., post free.

BOARD OF AGRICULTURE AND FISHERIES.

Fertilisers for Market Garden Crops.

Concentrated fertilisers are used by market gardeners to an increasing extent, but many growers still rely wholly on town dung.

Market gardeners often apply 25 tons of town dung per acre at one time, and sometimes even 50 tons per acre. This is very expensive, for, although the cost varies according to locality and facilities for transit, town dung probably costs, on an average, when all charges are paid, nearly 7*s*. per ton weight, and in many cases more.

Town dung is poor in quality as compared with cake-fed farm-yard dung. Its value depends largely on its organic matter, which, in the case of light and sandy soils, helps to retain moisture in dry weather, while in the case of stiff clay soils it prevents baking and keeps the soil open and spongy.

It is probable, however, that, except on very light and open soils, the merely mechanical or physical effects of town dung might be sufficiently obtained from the use of smaller quantities than are commonly used, while for many crops its use may be economically intermitted.

This view is supported by experiments carried on during the last eighteen years on a variety of vegetable and fruit crops on a weald clay farm in the neighbourhood of Hadlow, near Tonbridge, Kent. From these experiments (fully described in the Journal of the Board of Agriculture for March, 1903, and still in progress, 1911), it appears that, in the case of most vegetables, town dung alone will not give maximum crops unless very large quantities are used; and that the cost of such heavy dunging is greater than would suffice to produce the same result if less dung were used, supplemented by chemical or concentrated fertilisers.

The following general recommendations for the manuring of market garden crops are based mainly on the results of these experiments.

It must be understood that by "dung" is meant throughout, *not* farmyard dung, but ordinary town dung. The dressing of about 12½ tons per acre, frequently mentioned in the following pages, is equivalent to 25 small cart loads of town dung in a fresh, loose condition.

The recommendations given are for heavy land, or loams of fair or "medium" consistency. On decidedly light and freely draining soils, 2 cwt. of the total nitrate of soda prescribed may be replaced by about 8 cwt. rape meal, or 5 cwt. of fish guano applied before sowing or planting, at the same time as the phosphates and potash salts.

Cauliflowers and Broccoli.

A light dressing of town dung (12½ tons per acre) may be recommended, with from 4 to 6 cwt. of superphosphate, 4 cwt. of kainit, and 4 cwt. of nitrate of soda per acre, the nitrate of soda being divided into two dressings. A good crop, however, may be grown without dung by using 6 cwt. of superphosphate, 4 cwt. of kainit, and 6 cwt. of nitrate of soda per acre, the last-named being divided into two or three dressings.

Autumn Cabbages and Savoys.

A dressing may be recommended of 12½ tons of town dung, with 6 cwt. of superphosphate per acre; 6 cwt. of nitrate of soda per acre should be used as a top dressing for autumn cabbages, or 4 cwt. for savoys, one half of the nitrate being applied at the time of planting, and the remainder a month or two later. If dung cannot be spared the quantity of nitrate of soda may be increased to 8 cwt. per acre for autumn cabbages, or 6 cwt. per acre for savoys. In the absence of dung, on light land, 1 cwt. of sulphate of potash or 4 cwt. of kainit may be mixed with the superphosphate.

Spring Cabbages.

By spring cabbages is meant the crop planted in autumn and harvested in spring. These are usually dunged, but, as they are not so subject to drought as spring-planted crops, they may be planted without further dung than the residue left in the land from that applied to the previous crop. They should, however, at the time of planting, receive a dressing of 6 cwt. of superphosphate per acre. Nitrate of soda at the rate of not less than 4 cwt. per acre may be applied during the spring, divided into two dressings; but the quantity of nitrate may be advantageously increased to 6 cwt.

Brussels Sprouts.

These, on soils of fair consistency, may be readily and economically grown without dung, provided that concentrated fertilisers are liberally used. A good dressing is 6 cwt. of superphosphate and 4 cwt. of kainit per acre,

applied just before planting, from 4 to 6 cwt. of nitrate of soda being afterwards used as a top dressing, divided into two applications a few weeks apart.

On light sandy soils that suffer easily from drought, however, some dung should also be given.

Winter Lettuces.

Winter lettuces may be grown without fresh dung on ground dunged for the preceding crop. Experience indicates that if a grower has used anything like 25 tons of dung per acre for the last crop, whatever it may have been, he may safely plant winter lettuces on the same land without any further manuring. If, however, he plants winter lettuces in succession to a crop that has been only moderately dunged, he may give about 4 cwt. of superphosphate and 2 cwt. of nitrate of soda per acre—the latter, of course, being applied during the spring.

Summer Lettuces.

Summer lettuces, however, should not be left without dung lest they may suffer from drought early in the season. A light dressing of dung, with from 4 to 6 cwt. of superphosphate per acre, should be applied before planting, and 2 cwt. of nitrate of soda per acre applied as a top dressing.

Summer lettuces grown thus do not appear to need any special application of potash.

Carrots and Parsnips.

Most market gardeners probably do not dung carrots or parsnips, but grow them on land dunged for the preceding crop.

If a grower has used as much as 25 tons of dung per acre for the previous crop, it will probably pay best to plant carrots or parsnips without further manuring. But following only a moderate quantity of dung for the last crop, he should give carrots or parsnips from 4 to 6 cwt. of superphosphate and 1 cwt. of sulphate of potash per acre, followed by a top dressing of 2 cwt. of nitrate of soda per acre after the plant is well up. In the case of carrots a further dressing of 2 cwt. of nitrate per acre may in some seasons be given with advantage a month later.

Potash salts should on no account be omitted for either carrots or parsnips.

Summer Spinach.

A light dressing (12½ tons per acre) of dung may be recommended on heavy or medium land, with from 4 to 6 cwt.

of superphosphate and from 4 to 6 cwt. of nitrate of soda per acre—the nitrate applied in dressings of 2 cwt. per acre each.

In a good season, especially on land recently dunged for another crop, a good crop of spinach can be raised without any fresh dung if the phosphates and nitrate of soda are supplemented by 4 cwt. of kainit or 1 cwt. of sulphate of potash per acre ; but the combination of dung and concentrated fertilisers is probably safer.

Winter Spinach.

Winter spinach has been grown successfully after the removal of the summer spinach, without extra manuring, on heavy land. On light land it might be desirable to give a further top dressing of 2 cwt. per acre of nitrate of soda—without, however, repeating the application of dung or superphosphate.

Beetroots.

A light dressing of dung is desirable, with from 4 to 6 cwt. of superphosphate, 1 cwt. of sulphate of potash or 4 cwt. of kainit, and 2 cwt. of nitrate of soda per acre, the nitrate being applied shortly after the plant is up. If no dung is used, a second top dressing of 2 cwt. of nitrate per acre may be given. On most soils, however, the application of a moderate quantity of dung is valuable for securing a plant if the season should prove dry.

Potash is not always necessary when dung is used, but in some seasons it tells, and should therefore not be omitted.

Rhubarb.

A light dressing of town dung is recommended (12½ tons per acre), and from 4 to 6 cwt. of superphosphate per acre, with 4 cwt. of nitrate of soda per acre for small varieties, or 6 cwt. for large varieties. Sulphate of potash (1 cwt. per acre) or kainit (4 cwt. per acre) has proved useful for small varieties, and in some seasons has been of benefit to the coarser varieties.

Rhubarb grown with a combination of dung and concentrated fertilisers grows more rapidly, and is more tender and less stringy than that grown with dung alone.

Potatoes.

For early potatoes, on soils as heavy as that of Hadlow, 25 tons of dung per acre have consistently proved more economical than a lighter dressing, even when the latter is liberally supplemented by concentrated fertilisers. Early potatoes are very dependent upon rain, and summer rain has on the average been scarce during the seasons of experiment.

For late potatoes, the best results at Hadlow have been obtained from light dung, phosphates (say 4 to 6 cwt. of superphosphate per acre), 1 cwt. of sulphate of potash, and 4 cwt. of nitrate of soda per acre, the nitrate being applied in two dressings.

In the presence of dung, potash has produced little effect on the early potatoes, but much on the late varieties.

On light soils 2 cwt. of the nitrate of soda might be replaced by 2 cwt. of sulphate of ammonia (applied before planting) for the early varieties, or by 8 cwt. of rape meal, or 5 cwt. of fish guano for the late varieties ; 2 cwt. of nitrate of soda per acre being applied as a top dressing.

Spring or Summer Onions.

With regard to this crop, the experience at Hadlow is too limited to yield such definite recommendations as for other crops, for in some years the plant failed owing to drought or wireworm, and the soil is too stiff. A light dressing of dung, supplemented by 4 to 6 cwt. of superphosphate, 1 cwt. of sulphate of potash (or 4 cwt. of kainit), and 4 cwt. of nitrate of soda per acre, may, however, be regarded as a safe dressing, giving as good results as heavy dressings of dung.

Potash appears to be of vital importance to onions, and should on no account be omitted.

Tripoli Onions.

The results point to the general economy of a light dressing of dung, with from 4 to 6 cwt. of superphosphate, 1 cwt. of sulphate of potash (or 4 cwt. of kainit), and not less than 2 cwt. of nitrate of soda per acre. In some seasons a further 2 cwt. of nitrate of soda per acre (4 cwt. per acre in all) has proved to be economical.

Asparagus.

Excellent results may be obtained by the use of a light annual dressing of town dung (say 12½ tons per acre), 4 to 6 cwt. of superphosphate, 4 cwt. of kainit, and from 2 to 4 cwt. of nitrate of soda per acre. Asparagus thus grown has been found to develop more rapidly than when heavy quantities of dung are used without concentrated fertilisers, and the produce has been more tender and succulent, and of better flavour, on the " combination " plots than where dung alone was used.

Dwarf French Beans.

These may be grown with a light dressing of dung, from 4 to 6 cwt. of superphosphate and 1 cwt. of sulphate of potash (or 4 cwt. of kainit) per acre. The use of 2 cwt. of nitrate of soda per acre has in three seasons given a very

substantial advantage, increasing the average weight of beans gathered from less than $3\frac{1}{4}$ tons per acre to over $4\frac{1}{2}$ tons, an advantage of nearly 50 per cent.

Green Peas.

In the case of green peas, as far as mere *weight* is concerned, no substantial advantage has so far been found to arise from the use of nitrate of soda, a good crop being grown from a light dressing of dung with a dressing of phosphates and potash salts. The *quality*, however, of the peas has been improved by the addition of 2 cwt. of nitrate per acre, both as regards colour, texture, and taste.

Globe or Thistle-headed Artichokes.

The results of five years' cropping on the same plantation showed that a combination of concentrated fertilisers and light dung gives much better results than heavy dung. Probably the best dressing is about $12\frac{1}{2}$ tons of town dung, 6 cwt. of superphosphate, 1 cwt. of sulphate of potash (or 4 cwt. of kainit), and from 2 to 4 cwt. of nitrate of soda per acre. This combination gives on the average a much earlier crop of heads than where dung only is used. This is important to growers who supply the London markets, for artichokes grown in the early part of the season are more easily marketable.

Jerusalem Artichokes.

For this crop the same recommendations may be followed as have been made for winter lettuces.

Celery.

Celery, except on soils particularly well adapted to its cultivation, cannot, probably, be grown with any great success without the use of very much larger quantities of dung than are necessary for other crops. The dung should be placed in the trenches, together with a dressing of phosphatic manure. The crop may, during its growth, be occasionally top-dressed with nitrate of soda.

The use of the concentrated fertilisers may not much increase the crop, but will tend to make the celery more crisp and tender than that grown by the use of dung alone.

Strawberries.

Although the strawberry plant contains a good deal of potash, the direct application of potash salts appears to be unnecessary and in some years has appeared to be even deleterious rather than otherwise to the yield. The best general treatment is probably a light annual dressing (about 12 tons per acre) of town dung, with from 4 to 6 cwt. of superphosphate and 2 cwt. of nitrate of soda per acre.

Gooseberries.

A light dressing of dung (about 12 tons per acre) with 4 to 6 cwt. of superphosphate, 1 cwt. of sulphate of potash, and 4 cwt. of nitrate of soda per acre has given much better results with gooseberries than heavier dressings of town dung without concentrated fertilisers.

Potash appears to be a very essential ingredient of a successful gooseberry manure. The crop of gooseberries at Hadlow, over several years, was, on the potash-dressed plots, not far short of double that on the plots which received no potash.

If nitrate of soda be used as the sole nitrogenous addition to dung, not less than 4 cwt. per acre should be applied.

Currants.

These may be manured like gooseberries.

Raspberries.

A dressing of 12 tons of stable dung per acre will generally suffice for a good crop. In the absence of dung, chemical fertilisers may be used as for gooseberries.

Plums.

Full crops may be grown without dung, using phosphates, potash salts and nitrate of soda as for gooseberries.

Apples.

A light dressing of dung, with annual dressings of 4 cwt. of superphosphate, 1 cwt. of sulphate of potash and 2 cwt. of nitrate of soda per acre, aids the growth of the trees and gives a good yield. Potash is important.

Both apple and plum crops depend more on season than on manure.

Kentish Cob Nuts.

These are very frequently in practice dressed merely with wool dust. Experiments at East Peckham indicate that a dressing of from 4 to 6 cwt. of superphosphate and 2 cwt. of nitrate of soda per acre greatly improves the appearance, and consequently the market value, of the nuts, although it may not increase the actual yield per acre.

Note as to Superphosphate.

In the foregoing notes, superphosphate has been recommended throughout. This is on the assumption that the soil to be manured contains a sufficiency of lime, that is to say, sufficient carbonate of lime to cause effervescence when a

mineral acid is poured on it. On land poor in lime, the place of superphosphate should be taken by a considerably larger weight of basic slag, or of Peruvian guano, or of fine bone meal, or of a mixture of superphosphate and bone meal, or of that form of precipitated phosphate which is now to be obtained under the name of "basic superphosphate"; or at any rate the use of one or other of these manures should be alternated every other year with that of superphosphate.

Other Concentrated Fertilisers.

If, in addition to nitrate of soda, other concentrated nitrogenous fertilisers are used, such as sulphate of ammonia, fish guano, dried blood, rape dust, &c., these should be put on earlier than the nitrate of soda; and in this case the quantity of nitrate would be decreased. It must be remembered, however, that the nitrogen in nitrate of soda is immediately available for plant use, and that the nitrogen in 1 cwt. of nitrate of soda goes farther, for the immediate crop, than the same quantity of nitrogen in the form of fish guano or rape dust or dried blood, or even—except in a wet season—of sulphate of ammonia. In fact, the choice between nitrate of soda and sulphate of ammonia, and their proportion to any other nitrogenous fertilisers used, is to be determined in individual cases by circumstances of soil, climate, and cost.

Cost of Manuring.

As a rule the concentrated fertilisers recommended in the foregoing pages will cost about £3 10*s*. per acre for heavy or medium land, or about £4 for light land. If town dung be taken at 7*s*. to 8*s*. per ton, the combination of $12\frac{1}{2}$ tons of dung and the concentrated fertilisers will come to between £8 and £9 per acre. Sufficient town dung to give as good a yield as the mixed dressings would probably cost £15.

Many market garden crops, however, can be well grown (except on very light or dry land) with chemical fertilisers alone at a cost of £3 10*s*. or so per acre, following some other crop that has been dunged.

4, Whitehall Place, London, S.W.,
May, 1904.

Revised, January, 1911.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Mussel Scale (*Mytilaspis pomorum*, Bouché).

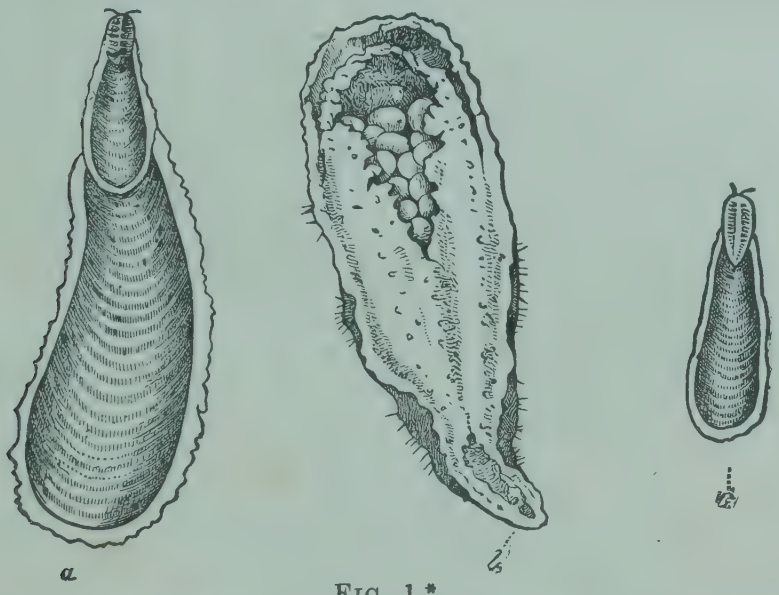

FIG. 1.*

a. Female Mussel Scale, dorsal view; *b*. The same, ventral view; *c*. Male scale.

The Mussel Scale is found chiefly on apple, but also on pear, currant, plum, and hawthorn. It has also been found abundantly on blackthorn in Devonshire. This pest, one of the most injurious scale insects existing in Great Britain, is found in North America, and also in Australia, New Zealand, and South Africa, where it has been imported on nursery stock. In this way it is also largely distributed in this country. Old trees and neglected orchards chiefly encourage the scale, but young stock suffer from its effects far more than old.

The scale insect damages the trees by sucking out the sap by means of a long, flexible mouth which it inserts into the plant tissues. It occurs not only on the trunk and boughs, but also on the leaf and fruit; it may frequently be found on imported apples.

Description.

This "scale" is frequently taken for growths on the bark, but it is the product of a minute insect belonging to

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* From "First Report on Economic Zoology" (F. V. Theobald), British Museum (Natural History).

the *Coccidæ*. The male and female insects differ in appearance and size, but the males are seldom observed.

Mature Scale.—The *female* scale (Fig. 1, *a* and *b*) is about one-eighth of an inch long, rounded behind, but tapering to a point at the head end. It may be straight or curved, and even much contorted. In colour it varies from deep brown to a colour approaching grey. The female scale insect is fleshy, legless, and provided with a long flexible proboscis. The *male* scale is much smaller than the female, and of the form shown in Fig. 1, *c*. The male scale insect is very different in appearance to the female, and is provided with two rather large wings.

The Larva.—The larva is very small, active, and six-legged. It is about one-hundredth of an inch long.

The Egg.—To the naked eye the eggs resemble small whitish dust.

The Scale.—As in all *Coccidæ*, the scale is a product formed by the insect which lives beneath it, partly by excretions from its body, and partly by the cast skins of the insect, the so-called *exuviæ*.

2.

FIG. 2.—Piece of branch infested with Mussel Scale.

Life-History.

The eggs are laid by the sedentary female under the scale. As many as 80 may be counted under a single scale, but the number varies considerably. The eggs give rise in the early

summer to the six-legged larvæ, which crawl from beneath the scales, and may be distributed from tree to tree by the wind, by birds, and by predaceous insects, such as lady-birds. In a few days they fix themselves to the plant by their short proboscis and draw away the sap ; the scale then commences to form by the excretion of a few waxy threads, and gradually grows to the form shown in figure 2. During this period the larva loses its legs and becomes converted into a fleshy legless creature ; the female remains feeding beneath the scale, with her proboscis inserted into the tissues of the plant. Towards the end of the summer she deposits her eggs and dies, her shrivelled skin remaining beneath the scale.

If the larva is to become a male, not only is a different scale produced (most often upon the leaves), but a totally different mature insect. The male undergoes a kind of pupal stage, and escapes from the scale as a small winged insect. The males are very rare, most of the females reproducing asexually. A single annual brood is the normal condition of things in Great Britain.

Treatment.

1.—The trunks, &c., of all trees should be kept clean, *i.e.*, free from rough bark, moss, and lichens. This can be done by washing in winter with the Woburn Wash recommended in Leaflet No. 70 (*Winter Washing of Fruit Trees*). It may be given as follows :—

Paraffin	... ...	2 gallons.
Soft Soap	... ...	$1\frac{1}{2}$ lb.
Caustic Soda	...	6 lb.
Water	... ...	28 gallons.

In order to prepare the wash the soft soap should be dissolved in a gallon of boiling water ; the paraffin should then be added, and the mixture churned thoroughly until a cream-like mass results. The thoroughness of the churning is important. (This paraffin-emulsion, if well made, will keep good for a long time.) The caustic soda should next be dissolved in the remaining 27 gallons of water and then poured into the paraffin-emulsion. The whole should be well mixed and used immediately. This wash has the advantage of destroying both scales and eggs.

2.—In cases of bad infestation a certain number of scales and eggs will be likely to escape the treatment, and hence a spray of paraffin-emulsion should be applied about the middle of June. This would account for the young scales not long hatched.

3.—Fumigation with hydrocyanic acid gas (*see* Leaflet No. 188) has proved a valuable scale remedy. There is no doubt that such fumigation is effective against the mussel scale in its active stages, but unfortunately experiment shows

that, with the ordinary strength used, the eggs of this scale are not affected by such fumigation.

It has hitherto been recommended to fumigate the young stock before or soon after planting. As, however, the Mussel Scale insect is then in the egg stage, such fumigation is no longer recommended. This does not invalidate the fumigation of young stock with hydrocyanic acid gas in the case of scales, *e.g.*, the Oyster-Shell Bark Louse (*Aspidiotus Ostreæformis*), where the stock sent out for planting has on it the scale in other than the egg stage.

Natural Enemies.

Scales have many natural enemies, but this species, like the currant scale, is not materially lessened by them in this country. Amongst the natural enemies, birds alone destroy them to any appreciable extent. The tits, and a few other birds, such as the tree-creeper and wryneck, feed upon them. Tits should always be encouraged in orchard and garden. Lady-birds and their larvæ eat scale, but none seem very partial to the Mussel Scale in Great Britain. Minute Hymenoptera (*Chalcididæ*) also live as parasites upon them, but seldom do any appreciable good. Fruit growers must wash the trees and ignore the very small amount of help given by these minute parasites.

4. Whitehall Place, London, S.W.,
June, 1904.

Revised, January, 1908.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Epizootic Abortion in Cattle.

This disease may be defined as a contagious affection of the pregnant uterus caused by the bacillus of cattle abortion, which usually, though not always, results in the fœtus being aborted.

Animals affected.

The disease is essentially a disease of cattle, but the other domesticated animals, such as the ewe, the goat, and the bitch, can be experimentally infected, and it is probable that they very occasionally contract the disease by natural infection owing to gross carelessness in the disposal of infected material from aborting cows.

The Microbe.

The microbe is a very small bacillus which may assume an oval or a rod shape. In the discharges, and in material taken from the after-birth of an aborting cow, the microbes are often found in characteristic clumps consisting of many bacilli, and these clumps are so typical in appearance that their presence in such materials enables one to diagnose the disease with great certainty. The bacilli can be stained with any of the aniline dyes.

Virulent material and Methods of Infection.

The contents of the infected uterus, that is to say, the fœtus, its membranes, and the exudate which the microbe has caused to appear on the mucous membrane inside the organ, are all virulent. In many cases the microbes are also very plentiful in the stomach and intestines of the fœtus. The infected animals, however, are not dangerous to others until they begin to discharge the uterine contents, but once these are discharged, they may contaminate the food and water supply. They may also be brought in contact with the genital organs of other animals by the latter lying on contaminated litter or dipping their tails into the continuous gutter which is so frequently to be found in cow-sheds behind the stalls. The virulent material may be carried some distance by dogs and foxes. It may also be carried on the hands and the boots of attendants. If the animal aborts at a very late stage of pregnancy, and the calf is born alive, it may carry infection to another establishment owing to the material in its intestines. It is particularly to be noted that the virulent material may preserve its virulence for several months if not

disinfected. The most common and the most important way whereby virulent material is carried from one establishment to another is through the agency of affected in-calf cows and cows which have aborted and are still discharging. The former by aborting may infect the new premises.

As regards the methods of infection, recent inquiry shows that infection of the pregnant uterus is readily brought about if virulent material be taken in by the mouth, and that this is the most important way in which natural infection takes place. The pregnant animals, therefore, can become infected by eating grass at pasture, or other food stuffs, and by drinking water, contaminated by the discharge from an infected animal. Infection can also take place owing to virulent material gaining entrance to the genital organs, but this method is not of so much importance in practice as infection through the alimentary canal.

With regard to the bull as a source of infection, it is not inconceivable that if he serves a clean cow a very short time after having served an animal which has very recently aborted he may infect the former. Under the ordinary conditions of farming, however, it is seldom that an animal which has aborted goes to the bull for a month or more after the act of abortion. By this time the discharge has usually ceased, so that the bull does not run much risk of contaminating himself. Moreover, it is comparatively seldom, except in the case of what is called a "co-operative bull" (that is to say, a bull kept by a society for serving the cows of a large number of small owners), that the bull will have the opportunity of serving a clean cow immediately after he has served one which has recently aborted. The bull, then, cannot be regarded as a carrying agent of the first importance, but is admittedly a factor in the spread of abortion, and infection in this way must be guarded against.

As regards infection in the case of cows which have aborted for the second or third time in succession, it does not follow that it is owing to the persistence of abortion bacilli in their organs. It is much more likely that they have been re-infected in the ordinary way. It is to be noted that the majority of animals, at least, acquire a considerable degree of immunity from the disease after one attack, but a proportion of them fail to acquire this immunity, and are thus capable of being re-infected.

Symptoms.

No immediate symptoms follow infection, but the disease runs an insidious chronic course, and, given an infected herd, one can never be sure which animal will carry her calf to full time. Some animals may abort a little more than a month after infection, but the majority do not do so until three or four months afterwards. Indeed,

an infected animal may sometimes carry her calf practically to full time, and give birth to it alive. When this happens it may usually be inferred that the animal contracted the affection at a late stage of pregnancy. When a cow aborts in the first, second, or even third month of pregnancy, the fœtus is often expelled completely enclosed in the membranes. At later stages the membranes are frequently retained after the fœtus has been expelled.

Premonitory symptoms are more likely to be observed in animals which abort after the third month of pregnancy. These premonitory symptoms may last one or two days or only a few hours. A discharge from the genital organs precedes the act of abortion, it may even be by one or two days. Usually, however, the discharge does not appear until immediately before the act. The discharge generally lasts for a month or somewhat less. At first only a little blood-tinged mucus is observed, but later the discharge is rather typical in appearance, and in the ordinary way is a good aid to diagnosis. Its colour is usually distinctly yellow, but it may be very dark brown. The more fluid parts are like pus, but clotted masses of the material are also frequently thrown out. They can be seen soiling the root of the tail or on the floor behind the animal. The condition of the udder often furnishes a valuable symptom of approaching abortion. The gland becomes somewhat swollen, and the animal is said to be making a bag before her time. The gland may even become suddenly and prematurely active when an animal is about to abort in the later stages of pregnancy.

Prevention.

Since abortion is spread chiefly through the agency of cows which have recently aborted and those which are pregnant and infected, it is of great importance, even though they have not yet aborted, to keep such cows away from pregnant bovine animals.

Although the bull, as recent enquiry shows, cannot be considered a factor of the first importance in the spread of abortion, it would be wrong to disregard him altogether as a means of spreading the disease. The greatest danger from the bull is to be anticipated from what has already been referred to as a "co-operative" bull. When contagious abortion exists amongst the animals of a "Bull Society" it would be well for those with clean herds not to send their cows to the Society's bull, unless effective measures have been taken to prevent any cows which have recently aborted being sent to him for service. In fact, it will always be a wise precaution not to send a cow to any bull on premises

where contagious abortion exists, unless a reliable guarantee can be obtained that the bull is not used for the service of cows which have aborted. If, however, it be necessary to send cows to a bull which comes in contact with animals which have aborted, it should be a rule that the genital organs of the male be thoroughly washed with an antiseptic solution (such as corrosive sublimate 1—2,000) some little time before he serves, unless an assurance be given that he has been disinfected immediately after a service which might have contaminated him.

It has already been mentioned that an infected cow is not dangerous until she begins to evacuate the contents of her uterus, and that the premonitory symptoms of abortion frequently show themselves before the act takes place. On every establishment where breeding cows are kept these premonitory symptoms should always be carefully looked for, and should they be observed the animal concerned should be removed immediately to a special shed. The vacated stall and immediate surroundings should at once be disinfected with a liberal quantity of quick lime. Should an animal abort before such measures can be taken she should nevertheless be removed from the other pregnant animals, and every part of the building with which her discharges have come in contact (these would be mainly the flooring, gutter, and stall) should be immediately disinfected. Everything which comes from an aborting cow should be destroyed, and everything which has been used for lifting or carrying the material (barrows, spades, forks, &c.) should be thoroughly disinfected. The best way to destroy the material from an aborting animal is to burn it, but if this cannot be carried out it should be put in a fairly deep pit and completely covered three or four inches deep with quick lime. After this has been done the lime should be quickly slaked by pouring very hot water into the pit, and immediately the lime has absorbed the water the pit should be quickly filled in with earth, so as to cause the heat from slaking to be retained for some time. In using quick lime as a disinfectant for floors, &c., a large quantity should be employed, not less than four times the bulk of the material upon which it is to act. It should be well mixed with this material, and then slaked with water as hot as possible, the object being to get a sufficient amount of heat developed during the slaking process to sterilise the infective material. For disinfecting purposes a 3 per cent solution of carbolic acid, or a 1 in 2,000 solution of corrosive sublimate, may be usefully employed. Infected litter should be removed from the cowshed, soaked in paraffin and burned.

So long as there is any discharge from the genital organs of an animal which has aborted the genital passages should be syringed out twice a day with a mild antiseptic solution,

and the flooring behind the animal should be disinfected at least once daily. A cow after aborting seldom discharges for more than a month. Such an animal should not be brought in contact with any pregnant females until the discharge has ceased; even if the latter appears to have ceased before a month is up it will be well to keep the animal isolated for that period at least. It must be remembered also that a discharging animal should not be isolated on a pasture or in contact with a water supply, because the discharges can infect the grass and water, and, as has already been pointed out, the virulent material may retain its virulence for months and so be infective. When the isolation period is completed, it is advisable to wash at least the posterior half of the animal with soap and water followed by a disinfecting solution such as a 1 in 2,000 solution of corrosive sublimate before putting the cow back amongst her fellows. It is advisable to kill or isolate a calf which has been aborted alive, as it may distribute infection.

No animal which has aborted should be sent to market or sold to another establishment until she has undergone the proper period of isolation and been disinfected, otherwise she may carry infection elsewhere. With some farmers it is customary to get rid of animals which have aborted. It should be pointed out, however, that animals which have suffered from an attack of the disease are usually more resistant to it than those which have not, and that by keeping animals which have aborted one may be better enabled to get rid of the disease, as the use of immunised stock is much more advisable for this purpose than the introduction of new animals. It may be mentioned that it is possible that immunisation methods which are at present being tried by the Committee on Contagious Abortion may eventually be of considerable service in getting rid of the disease. It is too soon, however, to recommend a trial of these methods except as an experiment. Although nothing definite can be stated regarding the efficacy of preventive inoculation in practice, it may at least be said that it does not do the animals any harm.

4, Whitehall Place, London, S.W.,
December, 1904.

•Re-written, February, 1910.

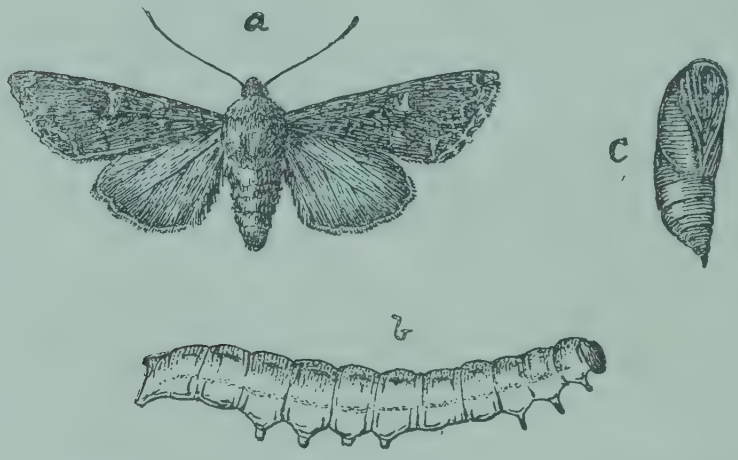
Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 19 Leaflets dealing with Diseases and Insect Pests of Farm Animals may be obtained from the same address, price 1d. post free.

Leaflet No. 109.

BOARD OF AGRICULTURE AND FISHERIES.

The Cabbage Moth (*Mamestra brassicae*).



a. Cabbage Moth, *b*. Caterpillar, and *c*. Pupa (all nat. size).

The caterpillars of the Cabbage Moth (*Mamestra brassicae*) are a great pest in gardens all over Great Britain and Ireland, and did much harm in 1903 in parts of the south of England. They are chiefly a cabbage pest, but they also attack a great variety of other plants, such as turnips, radishes, broccoli, cauliflower, strawberries, lettuce, currants, dahlias, mallows, marigolds, roses, geraniums, dock, goosefoot, tobacco plants. They are fond of maize, feeding amongst the male flowers, and by attacking the female spikes destroy the brush crowning them. In fact nearly all plants are devoured by this pest. The caterpillars are very greedy and spoil as well as eat the plants.

Description.

Moth.—The fore wings (*a*) are dark grey, varied with black, with many blackish streaks and marks ; the hind wings are brown, pale at the base with a whitish fringe ; thorax the same colour as the fore wings ; the abdomen brown with

more or less distinct tufts down the back, the tip being distinctly tufted ; the legs are brown and very hairy at the base. The wing expanse reaches about one inch and three-quarters, and the length of the body nearly or quite three-fourths of an inch. The moths fly at dusk and at night, remaining at rest upon tree trunks, palings, &c., during the day. They may also be found nestling against the sides of clods and stones in fields.

Caterpillar.—Like the moths, the caterpillars (*b*) are very varied in colour, the colour apparently depending upon the plants which form their food. When young they are always green, but as they grow the colour changes : some remain green, others become greyish-green, and some almost black on the back and yellowish above the feet ; below they are greenish-grey. There is sometimes a prominent dusky line along the back. The head is ochreous and horny and the first segment is blackish ; the legs and prolegs are all green and the spiracles pure white. When full grown they reach on an average an inch and a quarter in length ; the grown caterpillars roll themselves up into a ring if touched.

Pupa.—The pupa (*c*) is shining chestnut-brown, with occasional darker areas ; it may occur in a cell of earth, or it may be naked in the soil.

Life History.

The Cabbage Moth appears on the wing during the whole summer.

The eggs are laid on the leaves of plants, especially cabbages, and hatch in six or seven days.

The method of feeding of the caterpillars varies according to the plant attacked. When the larvæ are on a cabbage they eat their way into the heart of the plant, no matter how solid, and defile it with moist green excreta ("frass") which gives the cabbage a most disgusting appearance. Plants may be completely riddled by them. When attacking turnips, &c., they devour the leaves down to the midribs.

When mature the caterpillar either enters the ground to pupate, or may change on the surface, or under a stone or tile. Most of the caterpillars have pupated by the late autumn, but some only do so in the next spring. They may even be found in cabbages during the winter. The pupæ give rise to mature moths from May onward during the summer.

Methods of Prevention and Remedies.

1. All chrysalids should be destroyed when the ground is dug in winter. If large areas of cabbage have been attacked

it would be well to turn poultry on the land ; in garden cultivation, digging in the winter would turn up the chrysalids, and these could be collected or poultry employed as suggested above.

2. Hand-picking should be practised before the caterpillars have left the outer leaves and eaten their way into the heart.

3. Cabbages may be dusted with gas-lime which has been exposed to the air for three months or so : the lime runs down into the cabbages and makes them obnoxious to the larvæ without harming the plants, though it necessarily renders them less suitable for feeding or culinary purposes.

4, Whitehall Place, London, S.W.,
October, 1904.

Revised, September, 1906.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Carriage of Goods by Rail at Owner's Risk Rates.

Owner's risk rates are rates made by special contract, under the provisions of Section 7 of the Railway and Canal Traffic Act, 1854. They are generally lower than the ordinary rates, and in consideration of the reduction in the rate, the contract, which must be signed by the trader, and is only enforceable at law if its conditions are held to be just and reasonable, relieves the railway companies from their ordinary liability as carriers, except in the case of the wilful misconduct of their servants. Sometimes the consideration for the contract is not a reduction in rate, but the acceptance unpacked of goods liable to breakage or damage.

Traders have frequently complained that the terms of the existing contract pressed unduly upon them, and the subject came before the Railway Conference in 1908 for consideration. The Railway Conference, on which the Board of Agriculture and Fisheries were represented, was constituted by the Board of Trade, with the object of reviewing some of the more important questions that are raised from time to time between the railway companies on the one hand and the traders and general public on the other.

The grievances put forward on the part of the traders were mainly twofold :—(1) that the companies ought not only to be liable for wilful misconduct, which was difficult of proof, but should also pay compensation in extreme cases in which, for example, loss or damage was occasioned by the grosser forms of negligence on the part of the companies' servants ; and (2) that owing to the lowness of the owner's risk rates as compared with the corresponding company's risk rates, they are the only rates commercially possible for the ordinary trader.

The answer of the railway companies was that the reduced rates at owner's risk are a concession to the trader, and are the subject of a purely voluntary contract between the parties, which is almost invariably based upon other considerations as well as that of risk, and that it is always open to a trader to have his goods carried subject to conditions applicable to railway carriers at a rate within the company's statutory maxima, and that these had been recently settled by the Acts of 1891 and 1892.

The subject was fully discussed at the Conference, and certain amendments were suggested, and it was ascertained

that with a view of settling this controversy railway companies generally were willing to adopt these suggestions.

The Board of Trade have since been informed that the English and Scottish railway companies adopted as from January 1st, 1910, the recommendations made by the Conference.

The amendments are as follows :—

I.—*Goods carried in Merchandise Trains.* — The following addition to be embodied in the present consignment note for goods to be carried at owner's risk in merchandise trains, after the words "wilful misconduct of the Company's servants," viz. :—

But nothing in this agreement shall exempt the Company from any liability they would otherwise incur in the following cases of non-delivery, pilferage or mis-delivery except on proof that such non-delivery, pilferage or mis-delivery has not been caused by negligence or misconduct on the part of the Company or their servants.

1. Non-delivery of any package or consignment fully and properly addressed, unless such non-delivery is due to fire or accidents to trains.

2. Pilferage from packages of goods protected otherwise than by paper or other packing readily removable by hand, provided the pilferage is pointed out to a servant of the Company on or before delivery.

3. Mis-delivery where goods fully and properly addressed are not tendered to the consignee within twenty-eight days after despatch.

II. — *Perishable Merchandise carried in Passenger Trains* (*other than Milk in Cans*).—The following addition to be embodied in the consignment note for perishable and other merchandise (other than milk in cans), carried at owner's risk in passenger trains, after the words "wilful misconduct of the Company's servants," viz. :—

But nothing in this agreement shall exempt the Company in the case of perishable merchandise as defined by the Railway Rates and Charges Order Confirmation Acts, 1891–92 (other than milk in cans), from any liability they would otherwise incur in the following cases of non-delivery, pilferage or delay, except on proof that such non-delivery, pilferage or delay has not been caused by negligence or misconduct on the part of the Company or their servants.

1. Non-delivery of any package or consignment, fully and properly addressed, unless such non-delivery is due to fire or accidents to trains.

2. Pilferage from packages of goods protected otherwise than by paper or other packing readily removable by hand, provided the pilferage is pointed out to a servant of the Company on or before delivery.

3. Delay in transit exceeding forty-eight hours of any package or consignment, fully and properly addressed, as a result of which the value of the goods is deteriorated to the extent of three-fourths, if such deterioration is pointed out to a servant of the Company on or before delivery. Provided that in such case the Company's liability shall not exceed one-half the diminution in value of the goods.

III.—*Milk in Cans carried in Passenger Trains.*—The following modification to be embodied in the conditions of carriage for milk in cans carried at owner's risk by passenger train, viz. :—

Except in the case of milk carried oversea nothing in this agreement shall exempt the Company from any liability they would otherwise incur in the following cases of loss or delay, except on proof that such loss or delay has not been caused by negligence or misconduct on the part of the Company or their servants.

1. Loss of milk through non-arrival at the station to which it was consigned of a can fully and properly addressed, unless such non-arrival is due to fire or accidents to trains.

2. Delay in transit exceeding twenty-four hours to the station to which it was consigned of milk in cans fully and properly addressed, as a result of which the value of the milk is deteriorated to the extent of three-fourths, if such deterioration is pointed out to a servant of the Company on or before receipt by the consignee. Provided that in such case the Company's liability shall not exceed one-half of the diminution in value of the milk.

Carriage of Milk by Rail in Sealed Churns.—Attention is drawn to the fact that, according to information furnished to the Board by the Railway Companies Association, milk cans with lids sealed or otherwise fastened are conveyed by the Railway Companies at the same rates as are charged for milk in cans not sealed or otherwise fastened, provided the tare weight is stamped on the outside of the cans.

The Companies will in such cases accept the declaration of the senders as to the quantity contained in the can. They reserve to themselves the right to open the can to ascertain that the quantity contained therein agrees with the quantity declared, but this reservation is only intended as a protection against fraud and a can would only be opened in a case

where there was reasonable ground for believing that it contained a greater quantity of milk than had been invoiced.

It is, therefore, open to farmers to protect themselves against loss or other interference with milk while in transit by sealing or otherwise fastening their cans.

4, Whitehall Place, London, S.W.,
May, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W.

A pamphlet containing 12 leaflets dealing with Farm Animals and Dairying can be obtained from the same address, price 1d., post free.

BOARD OF AGRICULTURE AND FISHERIES.

Co-operative Egg and Poultry Societies.

The importation of eggs from abroad during the past thirty years has grown to an enormous extent, but since 1904 there has been a check in the quantities received. There is some ground for believing that this decline in foreign supplies may be more or less permanent, and as it has been accompanied by a rise in prices there is an excellent opportunity for British poultry keepers to secure a larger share of the trade than hitherto. The fact that British payments for foreign eggs exceed £7,000,000 annually shows that the egg business is not to be despised.

The value of an egg is determined chiefly by its freshness, so that where it can be sold near the place of production it should command a higher price than where its freshness is liable to be lost by transport over long distances. It is here that producers in this country have a natural advantage over foreign exporters, but in order to benefit by it the eggs must be dispatched promptly to market and sold both rapidly and systematically.

The small consignments which each producer is individually able to supply are usually only sufficient for a retail trade and prevent him from obtaining a footing in the large markets. It is only by co-operation that this difficulty can be overcome, and it is essential that the British producer should adopt the methods that have proved so successful not only abroad, but also wherever they have been tried in Great Britain and Ireland.

Egg Collecting Clubs.

The most elementary type of co-operation is an Egg Collecting Club. A club of this kind may be formed in any district where supplies have to be sent to a market town a few miles away, but where the number of producers is not large enough to set up a regular Co-operative Society. In such a case the cost and trouble of conveying individual lots to market may be reduced, and better prices obtained, by making arrangements for one person to receive, pack and forward the eggs. In most districts women can be found who will undertake this work for a small percentage on the receipts.

The total sum received for the eggs, less this percentage, should be divided weekly or monthly among the members of the club in proportion to the number or weight of eggs supplied by each member.

Cottagers or allotment holders living near one another may often adopt this arrangement with advantage in place of selling their eggs to higglers.

Co-operative Egg Societies.

In rural districts where the local demand is comparatively small, but where a fair number of producers exist, an endeavour should be made to form a Co-operative Society through which all the eggs produced can be sold under conditions which will ensure absolute freshness and consequently high prices. The Society should comprise all the farmers, small holders and cottagers within a radius of a few miles.

A number of such societies have been established within the last few years and have proved most successful. As a result of their operations, egg production in their districts has much increased, and better prices have been obtained all round. It is claimed that apart from the profits made by the societies the prices obtained by members have averaged about 2*d.* per dozen more than the prices obtained before the opening of these depôts. One of the most successful of these societies sold over two million eggs in 1908.

Formation of a Society.—When it is proposed to establish such a society, it is desirable to obtain the advice and assistance of the Agricultural Organisation Society, Dacre House, Dacre Street, Westminster, S.W., who will give all necessary assistance as regards the formation of Co-operative Societies in England and Wales, or of the Scottish Agricultural Organisation Society, 5, St. Andrew Square, Edinburgh, who are prepared to act in a similar way as regards Scotland.

Both these societies are organisations for promoting Agricultural Co-operative Societies, and do not themselves engage in trade.

The next step is to register the society under the Industrial and Provident Societies Act of 1893, in order that it may have a legal existence and be able to enter into contracts. A small fee is charged for this, but by registration members get a security which an unregistered society cannot get. The Agricultural Organisation Society have drawn up a set of model rules, which have been approved by the Chief Registrar of Friendly Societies, and which can be obtained on application to the Secretary of the Society.

In a district where an Agricultural or Industrial Co-operative Society already exists it may be possible to induce that Society to add the sale of eggs and poultry to its operations, and it is desirable to adopt this course wherever possible. In this case, it may be necessary for the existing Society to modify its rules slightly, but separate registration is not necessary.

Before commencing business Co-operative Egg and Poultry Societies are also recommended to join the National Poultry Organisation Society, of Regent House, Regent Street, London, W., which is a body established to aid the Poultry Industry and to organise the sale of produce. Through the Trading Branch of this Society local producers are more likely to obtain access to the best markets, and to avoid the danger of reducing prices by competing against one another.

Supply of Eggs.—The methods adopted by these Societies involve the establishment of a depôt in a convenient position near a railway, and arrangements for collecting, receiving, testing, packing, and selling the eggs on behalf of the members.

In order to secure a good reputation for the Society's eggs and to obtain the best prices, eggs should be sent to the local depôt not less than three times a week, no matter how few there may be in each individual case. Eggs not more than three days old, which are sold as "new-laid" usually command 20 to 25 per cent more than those which are five to six days old, as the latter have lost the quality desired for boiling, though excellent for frying or poaching.

A few eggs are received from France which are equal to English new-laid eggs, but the quantity is very small, and most of the foreign eggs imported from France, Denmark, Italy, Hungary and Russia are a fortnight old or more when received, according to the distance they have had to travel. Consequently, the older an English egg is when marketed the more it has to compete with foreign eggs, and the lower its price will be. The object of a Co-operative Society should be to supply eggs of a superior quality and freshness to any obtained from abroad, and thus secure the best of the trade for its members.

During the spring months of the year when hens are broody, eggs should be taken from the nests twice a day, as if they are sat upon for several hours eggs are spoiled. Every care should be taken to keep the shells clean by putting new straw in the nests, as washed eggs lose much in appearance and do not keep so well. Before eggs are sent in to the depôt they should be marked with the breeder's number in the local society, a rubber stamp being provided for the purpose, so that the origin can be traced.

Testing Eggs at the Depôt.—When received at the Depôt every egg should be tested for freshness by means of a special lamp. The trade requirements for new-laid eggs are that they shall be (1) clean in the shell and of good shape; (2) full, *i.e.*, have a small air space; (3) bright, *i.e.*, perfectly clear without any spots or shadows; and (4) from 2 to $2\frac{1}{2}$ oz. in weight. Eggs which conform to these

requirements should be selected, and all bad, stale or dirty eggs returned to the producers, while others which are not of first quality should be sold as cookers. The eggs should then be packed in special boxes and forwarded to their destination.

The National Poultry Organisation Society has registered a Trade Mark for first quality eggs, the use of which is permitted to associated societies, and this "Rose Brand" stamp is a guarantee of both origin and quality.

Payments for Eggs.—In paying producers, the plan recommended is to buy the eggs at the ordinary local market price, the profits remaining after payment of expenses being at stated periods divided among members and shareholders in accordance with the number of eggs sent in to the Depôt. In some cases it has been found necessary to make dividends depend upon the relative number of eggs produced in the winter, in order to prevent members selling eggs elsewhere when scarce and to the Depôt when plentiful. It is absolutely essential, however, that members of a Co-operative Society should recognise that the success of the Society depends on their treating it fairly and supplying to it all the eggs they have for sale.

Preserving Eggs.—It is frequently the case that for a few weeks in the spring supplies are in excess of the demand, and in order to avoid throwing large quantities on the market at low prices local societies have found it profitable to preserve their surplus eggs. This can be done better by them than by individual producers, and marketing is also greatly facilitated by societies undertaking this work. A leaflet (No. 83) on The Preservation of Eggs can be obtained from the Board on application.

Eggs for Hatching Purposes.—Besides the sale of eggs for table use a Co-operative Egg and Poultry Society may be in a position to undertake the provision and sale of sittings of eggs from reliable strains of both pure-bred and cross-bred poultry.

Sale of Poultry.—In many districts a Fattening Station would be a very useful adjunct of a Co-operative Egg Society, and would provide an outlet for poultry at enhanced prices. Larger premises would be required than for an egg depôt, as the birds must be kept for a period of three weeks, and a skilled operator must be employed to feed, pluck and shape the birds. In order to make such a station remunerative sufficient birds must be available to keep the man fully employed, unless part of his time can be devoted to other work, as it is obvious that the greater the amount of trade done the smaller will be the expenses in proportion to the turnover.

The sale of unfattened poultry might also be undertaken, as well as the provision and sale for members of high class stock birds.

Area covered by a Society.—The area covered by an egg and poultry society will vary in accordance with local conditions. A Society can be formed for two or three adjacent villages or for a still larger district. In the latter case sub-collecting stations should be established to minimise the cost of collection, with a Central Packing Depôt. As a rule the latter can be worked at a lower relative cost, and where preservation of eggs is part of the scheme it is possible to establish a fully equipped plant. An essential factor is that the area should not be so large that freshness is lost by transporting the eggs long distances, otherwise nothing would be gained.

Supply of Poultry Requisites.—A Co-operative Egg and Poultry Society may also find it advantageous to extend the business to other branches of trade. The committee could, for example, buy poultry appliances and food at wholesale rates for the members of the society.

Sale of Eggs by other Co-operative Societies.

An Agricultural Co-operative Society which has been established for the purchase of manures, seeds, &c., may often with advantage undertake the sale of eggs for its members in the same way as a Co-operative Society established purely for that purpose, and may be able to utilise to some extent the buildings it already possesses as an Egg Depôt.

Industrial Co-operative Societies also might materially assist in the development of the egg industry by purchasing direct from their members and others in the vicinity instead of obtaining their supplies from wholesale dealers. This is particularly the case with Co-operative Societies in small country towns, many of whose members are poultry-keepers.

A successful instance of this is afforded by the Wickham Market Industrial Co-operative Society, which at the beginning of 1906 undertook the collection of eggs, a branch of business for which it had special facilities, as its carts were regularly engaged in delivering goods to members scattered over a somewhat wide area. These carts in delivering groceries, and other goods, also undertook the collection of eggs, while, in addition, a cart was sent out specially once a week to supplement the other rounds.

The trade has rapidly increased, and in 1908 the number of eggs received was 452,000. Much better prices have been obtained by the members, and the Society has sold its surplus supply through the Co-operative Wholesale Society and other sources.

If this example could be more extensively followed it would be likely to lead to a substantial development in poultry keeping in this country. Poultry keepers who deal with a local Co-operative Society might urge that the Society should systematically undertake to purchase eggs from them.

4, Whitehall Place, London, S.W.
June, 1904.

Re-written, February, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 16 Leaflets dealing with Poultry and Bees, their Breeding and Management, may be obtained from the same address, price 1d. post free.

BOARD OF AGRICULTURE AND FISHERIES.

Weeds and their Suppression.

Damage done by Weeds.

The most serious objections to weeds may be stated as follows :—

1. They absorb from the soil moisture and manures which would otherwise go to nourish and increase the crop which is being cultivated.
2. They "crowd" the crop, screening from it that adequate amount of light, which is necessary for healthy growth and for the proper assimilation of the soil and air constituents ; in addition heat is restricted and the free circulation of air prevented. The effect of this screening is to hamper the growth of the plants during early life, especially in the case of crops of slow growth, while it prevents or retards ripening, particularly in the case of corn crops.
3. Many weeds,—*e.g.*, bindweed and cleavers—pull down cereals, or assist in their downfall, rendering the work of cutting at harvest both difficult and expensive.
4. Proper and thorough cultivation, and "singling" of root crops, are rendered difficult and expensive by a multitude of weeds.
5. Weeds may harbour, or favour the development of, insect pests, as charlock does the turnip "fly," or they may temporarily harbour rusts and mildews, which afterwards spread to the cultivated crops.
6. The pecuniary value of samples of cereals is reduced by the presence of cockle, garlic, cleavers, and vetches; the value of most seeds is lowered by the presence of the seeds of weeds ; and the market value of hay and other farm produce is similarly lowered by certain weeds or their seeds.
7. Some weeds—*e.g.*, garlic—taint the milk of cows which have fed upon them, whilst others—*e.g.*, meadow saffron, and water hemlock—are poisonous to stock.
8. Other weeds (dodder, broomrape, yellow rattle) are parasitic or semi-parasitic, and directly attack the crops they infest.
9. Weeds may cause stoppage of drains by means of their underground stems and roots.

Most farmers recognise that it is impossible to obtain the best returns from the land when weeds are allowed to grow unchecked. Experiment has shown that the yield on even a moderately weeded area may be from 40 to 50 per cent. higher than on a similar unweeded area.

Manner of Distribution.

Before the suppression of weeds can be intelligently dealt with, it is essential to have a clear conception of the manner in which weeds obtain access to the farm, and the methods by which they are spread broadcast amongst cultivated crops. The manner of distribution is very varied, but amongst the commoner processes are :—

a. Distribution by means of the wind. Many seeds, like those of the poppy, are so small that they are readily scattered considerable distances from the parent plant.

b. Distribution by means of a special parachute-like apparatus, or other arrangement, of fluffy hairs and flattened wing-like projections, by which seeds, such as those of the thistle, dock, groundsel, etc., are rendered buoyant, and easily carried about in a light breeze.

c. Distribution by means of farmyard manure. Screenings from threshing-machines, sweepings from barns and hay-lofts, etc., often find their way to the manure heap, while manure produced by feeding cattle on inferior hay is also likely to contain weed-seeds. Many seeds of weeds may be uninjured by the heat of fermentation, and will in due course pass to the fields. Some seeds may even germinate better after lying in the manure heap, or after passing through the stomach of an animal.

d. The use of impure seed is a potent means of introducing weeds to a farm. The presence of 1 per cent. of dock seed in a mixture of grass and clover seed means *ten or more dock plants per square yard* all over the field wherever such a sample is sown at the ordinary rate for leys.

e. Some weeds—*e.g.*, creeping thistle, couch, field bindweed—are spread by means of broken portions of the creeping rootstock, which may be carried from field to field or farm to farm in a variety of ways.

Methods of Suppression.

Weeds must be combated by somewhat different methods according as they are *annual*, *biennial*, or *perennial*, while it must be emphasised that, whatever methods are adopted

they must be promptly, vigorously and faithfully carried out: systematic well-timed effort is the foundation of success.

1. The most obvious mode of suppressing weeds is to prevent them seeding. When it is recognised that an ordinary charlock plant produces from 1,000 to 4,000 seeds, and a moderate-sized poppy 10,000 to 15,000, and large plants 50,000 seeds, the force of the adage that "one year's seeding is seven years' weeding" is obvious. Further, as many weeds produce seeds which do not germinate uniformly, the mischief is greater than at first sight appears, for they may lie for a time dormant in the soil and then come up after several years. The prevention of seeding should extend to weeds growing in hedgerows, on roadsides and waste places, and round farm buildings. Where reapers are employed at harvest many weed seeds may be caught by a box attachment to the back of the pan of the reaper.
2. Under no circumstances should imperfectly cleaned seed be either purchased or sown. At the same time care should be exercised as to the disposal of screenings, sweepings of haylofts, etc. Such refuse should either be burnt, or if it is given to stock it should be thoroughly ground or scalded.
3. Deep ploughing is sometimes resorted to with considerable success, many seeds rotting when deeply buried. Others, however, remain dormant under such conditions, without losing their vitality, and may subsequently be brought to the surface. Shallow cultivation and the preparation of a good tilth are more advisable, as by this means the seeds are encouraged to germinate, when they may be destroyed by further stirring of the soil. Such a method, taking care to keep the seeds near the surface, will clear the ground of many annual and biennial weeds, such as poppy, charlock, and some species of thistle.
4. The eradication of perennials, such as couch, field bindweed, and creeping thistle, needs careful and well-directed effort. These plants are propagated by underground runners bearing buds, and the best treatment where they are concerned is shallow ploughing and thorough cultivation, the weeds being collected and burnt. Or the weeds may be brought to the surface and left to the drying effects of wind and sun. The weeds named may also be combated as described in paragraph 6.

5. Hand-pulling and total removal of weeds is the most efficient means of destruction. Digging with fork or spade, or collection by means of the harrow after being loosened with the plough may also be adopted, but these methods are all expensive, and only resorted to when other plans have failed or are inapplicable. In every case the weeds collected should be burnt or composted with lime.
6. Judicious cutting with spade, hoe, or scythe, will destroy all weeds, but ill-timed cutting may only encourage what it is desired to suppress. Many weeds when cut near the ground send up new stems, and these are produced at the expense of food stored below ground in the previous season. The growth of these secondary stems weakens the plant as a whole, and if, when produced, they are immediately cut off, and the process repeated, total destruction will be the result, no matter what the plant may be.

The first cutting should be early in the year, and as often after that, throughout the summer, as new shoots appear. If left too long they may either seed, or again store up food in the roots in preparation for the next season's growth. One cutting in the case of perennials like creeping thistle, field bindweed, couch, and coltsfoot is quite valueless.

7. Rushes, sedges and horsetails are indicative of a sour soil, and this can only be remedied by draining and liming.
8. The application of manure and artificial fertilisers induces considerable changes in the character of the herbage on pastures, and of the weeds on arable land. For example, nitrogenous manures stimulate the growth of useful grasses, which tend to choke out buttercups, cowslips, and other weeds or less useful plants. The sour condition of the surface soil can be partially remedied by a dressing of lime, which is, more or less, a specific against sorrel, corn marigold, spurrey, and some other weeds. The application of 5 to 8 cwt. of basic slag per acre to pastures on stiff clay land often has a wonderful effect in encouraging clovers and generally improving the herbage.
9. Weeds may often be suppressed or much reduced by the growth of dense, heavy "smother" crops which choke out weeds. On foul land such crops may be of much value before or after a well-hoed root crop. Suitable crops for the purpose are vetches, mustard, rape, rye, trifolium, lupins, serradella, sainfoin, lucerne, and maize—the last-named being especially valuable, because it is not only thoroughly hoed but casts a dense shade.

10. Close feeding with sheep will often check certain plants and prevent them seeding, *e.g.*, ragwort, yellow rattle, and hardhead or knapweed.
11. Finally, spraying crops with chemical substances, more especially with sulphate of copper (bluestone) and sulphate of iron, has been found exceedingly useful in destroying weeds. The destruction of charlock in corn crops by spraying is dealt with in Leaflet No. 63. Solutions of the sulphates of copper and iron, however, may be employed against other weeds, some of which may be destroyed and others crippled. Persicaria and spurrey may respectively be killed by spraying with 4 and 5 per cent. solutions of copper sulphate ; while the following weeds are more or less crippled and seeding largely prevented by spraying with a 5 per cent. solution of copper sulphate, or a 15 per cent. solution of sulphate of iron :—Poppy, corn cockle, black bindweed, dock, groundsel, dandelion, perennial sow thistle, cornflower, thistles, and coltsfoot.

4, Whitehall Place, London, S.W.,
June, 1904.

Revised, January, 1911.

NOTE.—Other Leaflets dealing with weeds are :—

No. 63. The Destruction of Charlock.
No. 166. Some Common Thistles.
No. 180. Dodder.
No. 194. Coltsfoot.
No. 222. Meadow Saffron.
No. 226. Broom-rape.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 113.

BOARD OF AGRICULTURE AND FISHERIES.

Dry Rot.

(*Merulius lacrymans*, Fries.)

As a destroyer of timber used in the construction of dwelling-houses, the fungus popularly known as "dry rot" has been well known for many years. Notwithstanding modern improvements in ventilation, &c., the disease appears to be gradually gaining ground. This is chiefly owing to the following causes: (1) the use of immature and imperfectly seasoned wood; and (2) the rapidity with which modern houses are built, resulting in the imprisonment of a superabundance of moisture in the material used.

Infection with the dry rot fungus sometimes takes place in the forest, when felled timber remains stored there for some time. The first evidence of such infection is indicated by the presence of red stripes in the sawn wood. If such wood be thoroughly seasoned the mycelium present in the red stripes is killed. If the seasoning be neglected, or imperfectly done, the mycelium, which possesses the power of remaining in a latent condition for some time, commences active growth when the wood is used in any part of a building where it is exposed to dampness, and this in some cases is unavoidable, as when the ends of joists are built into a wall.

Under such circumstances dry rot eventually appears.

On the other hand, the fungus is by no means rare on old beams and boards stored in wood-yards, &c., and it is mainly from such sources that spores, or portions of the spreading mycelium, are introduced into buildings by new wood which has become infected.

Again, when a house that has suffered from dry rot is being repaired, sufficient care is not exercised in the immediate destruction by burning of all diseased wood; and portions that are not too much decayed are often stored for repairing purposes. In consequence the air in towns always contains spores of the dry rot fungus.

During the building of a house the danger arising from the presence of dry rot may be reduced to a minimum by taking proper precautions.

A thorough system of ventilation and the avoidance of damp, stuffy places is of primary importance. The endeavour to exclude dry rot by hermetically closing all communication with the outer air in the spaces between flooring-boards and joists, and similar places, has been practically demonstrated to be an utter failure. In the case of a recently constructed mansion the expenditure of many thousands of pounds was entailed in rectifying the consequences of such a proceeding.

Perhaps the greatest source of danger arises where the ends of joists are built into a wall near the basement of a house, and this is more especially true where there is evidence of red stripe in the wood. As a precaution, the ends of joists should always be treated with creosote. Coal tar is not recommended, as its power of penetrating into the wood is very limited, and by forming a waterproof coating it prevents the wood from drying.

A frequent cause of trouble is the use of damp deadening material, or "pugging," and covering it over with boards before all the moisture has evaporated. Such material should be used as dry as possible, coarse sand being the best for the purpose. The surface of boards coming in contact with deadening material should first be painted over with methylated spirit containing corrosive sublimate in solution—six ounces to one gallon. The spirit evaporates, leaving a coating of corrosive sublimate on the boards, which completely destroys any mycelium coming in contact with it.

It has been proved that the spores of dry rot can only germinate in moisture containing some alkali in solution, hence coal-dust, cinders, or any kind of humus should never be used for deadening or packing.

The fruit of the dry rot fungus presents the appearance of irregularly shaped, flattened or undulating patches of variable size, adhering by their entire under surface to the substance on which they are growing. When mature the central portion of the patch is covered with an irregular network formed by slightly raised anastomosing ribs, and is of a rich brown colour, due to the enormous quantity of spores, which are deposited on surrounding objects under the form of snuff-coloured powder. These spores are diffused by currents of air, or by rats, mice, and insects.

The margin of the fruiting patch is surrounded by a snow-white fringe of mycelium, which spreads in every direction over surrounding objects, creeping up walls and passing through crevices, the advancing mycelium being supplied with food and moisture from the parent plant growing on wood.

This food is conducted through cord-like strands which form behind the thin advancing margin of mycelium.

DRY ROT.

Owing to this supply of food from a central source, the mycelium can extend over stones and other substances not containing food, and thus spread from the basement to the top of a house. Each time the migrating mycelium comes in contact with wood, the latter is attacked, and a new centre of food-supply is established from which strands spread in search of other sources of food. The mycelium often forms felt-like sheets of large size that can readily be removed intact. These sheets are white at first, but soon change to a pale grey colour, a character by which dry rot can be readily distinguished from another wood-destroying fungus, *Polyporus fomentarius*, even in the absence of fruit, the felted mycelium of the latter remaining permanently white.

The spreading mycelium can be checked by the application of carbolic acid, and when its presence is once detected, all wood-work that can be reached should be thoroughly saturated with the same substance.

The specific name of *lacrymans* or "weeping" alludes to the power of the fungus to attract moisture from the atmosphere. Under certain conditions moisture is absorbed to such an extent that it hangs in drops, or even drips from the surface of the fungus. This moisture assists very materially in rotting the timber, which afterwards becomes quite dry and friable. Hence the popular name "dry-rot," which alludes to the last, and most frequently observed, stage of decay.

4, Whitehall Place, London, S.W.
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Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 114.

BOARD OF AGRICULTURE AND FISHERIES.

The Feeding of Poultry.

Poultry keeping is one of the smaller agricultural industries which no occupier of land should neglect. Cottagers and small holders, in particular, will find the production of eggs or of table poultry a remunerative branch of their business, though it can very rarely be relied upon as the sole or the principal source of income.

One of the most important factors making for success in poultry-keeping is the correct solution of the feeding problem. Improper methods of feeding will almost certainly result in loss instead of profit.

Natural foods, that is, those substances which birds at liberty will gather for themselves, form a very valuable asset to the poultry-keeper, for they are better and cheaper than purchased foods, and tend to keep poultry in a vigorous condition owing to the fact that in seeking for them a large amount of exercise is taken. The birds, therefore, should be given the run of as large an area of land as possible. It is necessary to supplement the natural contents of the soil by the use of cultivated crops, but the larger the amount of natural food gathered by the birds the lower will be the cost of feeding, and the greater the profit.

The quantity of food required to keep poultry in health varies not only with the breed, but with individual members of the same breed, while much depends upon the natural food available. As an instance of the variation in the consumption of food it may be stated that tests carried out some years ago indicated that a Leghorn can thrive on much less supplementary food than is necessary for a Cochin, while it would probably produce four times the number of eggs annually.

The mixtures used in feeding fowls must be made up in accordance with the specific object in view. Chickens require foods suited to their special needs at different stages of their growth, and they must also be fed according to the ultimate use to which they will be put, whether for stock purposes or for marketing as table poultry. Again, breeding stock require different feeding from those kept purely for egg production. Climatic influences must also be taken into account. Food suitable for a cold, exposed, elevated situation, would not be so beneficial in a warm sheltered position. If success is to be attained all these points must be taken into consideration. *Supplied foods should supplement and not replace those obtained naturally.*

A plentiful and pure supply of water is a necessary adjunct to feeding, both in the case of chickens and adult birds. Fresh water should be available at all times, and the

water vessels or troughs should be kept scrupulously clean. An exception may be made in the case of birds put up for fattening, as the food is then given in a semi-liquid condition and water is unnecessary.

Chicken Feeding.

Practical poultry-keepers are divided in opinion as to the better method of feeding chickens, and two systems are practised. Until some eight or ten years ago the wet mash or soft food method was generally employed, but since that time dry feeding has been introduced. Each system possesses certain advantages, but it is probable that the latter produces better results, and also involves less labour. It should not, however, be employed alone. Whichever method is adopted, the first feed should be withheld for a considerable time after the chickens are hatched. It is customary to give the first meal when they are about 24 hours old, but as the newly-hatched chicks are provided with sufficient yolk to maintain life for several days, it has been found preferable to give the first meal when they are from 60 to 72 hours old.

Dry Feeding.—As its name implies, the dry method consists in giving a mixture entirely composed of unsoaked foods. For this purpose a mixture is prepared containing a number of the smaller grains and a few of the larger in a broken state. The following has been found a suitable dry chick feed for the first month :—

Mixture A.—

Wheat (cracked) ...	3 parts.	Broken maize ...	1 part.
Dari...	2 „	Hempseed and buckwheat, each ...	½ „
Canary seed ...	2 „	Rice	1 „
Oatmeal	2 „	Meat (granulated)...	1 „
Millet	2 „	Grit	1 „

(All parts by weight. To make 1 cwt. 1 part = 7 lb. Cost about 11*s.* 6*d.* per cwt).

When the chickens are a month to five weeks old soft food or wet mash should be introduced into the diet. This is best given as the first morning meal, and a variety of substances can be used. The following alternative mixtures will be found suitable :—

1.—Biscuit meal ...	17 parts.	Soaked in boiling water and dried off with ground oats or barley meal.
Granulated meat..	3 „	
2.—Barley meal ...	6 parts.	Mixed to a crumbly moist state with boiling water.
Toppings... ...	6 „	
Granulated meat	3 „	
3.—Ground oats ...	14 parts.	Mixed to a crumbly moist state with boiling water.
Granulated meat	3 „	
4.—Cooked rice ...	8 parts.	Dried off with ground oats or barley meal.
Granulated meat	1 part.	

At the same time the smaller and more expensive grains may be omitted from Mixture A., which may be changed to :—

Mixture B.—

Wheat (cracked) ...	3 parts.	Hempseed	1 part.
Maize „ ...	2 „	Meat (granulated) ...	1 „
Dari...	2 „	Linseed	1 „
Buckwheat ...	2 „	Grit and oyster shell	1 „
Rice	1 part.		

(All parts by weight. To make 1 cwt. 1 part = 8 lb. Cost about 8*s.* 6*d.* per cwt.)

This food may be used for three weeks or a month, when two feeds of soft food at 7 a.m. and 2 p.m, and two of Mixture B. at 10 a.m. and 4 p.m. will be sufficient for the birds. If the chickens are destined for early killing the 10 o'clock meal can be of soft food instead of the mixture. At three months old the number of meals should be reduced to three per day, namely, for production of stock or laying birds :—

7 a.m. Soft food.
11 „ Wheat, buckwheat, dari or barley.
4 p.m. „ „ „

or for table poultry :—

7 a.m. Soft food.
11 „ „
4 p.m. Wheat, buckwheat, dari or barley.

An important point in connection with dry feeding is the manner in which the seeds and grains are given. To place them before the birds in troughs at the times stated is not enough, for it is essential that the birds should have plenty of exercise. In fact, it is probable that the value of dry feeding is mainly due to the fact that the birds are compelled to scratch for their food as they would do in a state of nature. The floor of the brooder or rearing house should be thickly littered with cut chaff, straw or dried leaves, and the dry mixture scattered therein. Scratching by chickens is instinctive, and they will seek the food from the first, and scratch busily all day long. As a result they will be more vigorous and be better able to withstand climatic variations which might otherwise be fatal to them. In one instance where the mortality during the first fortnight had been forty-nine per cent. among chickens fed on soft food, it was brought down to five per cent. by the adoption of dry feeding. Though wet mash is excellent for natural rearing, dry feeding appears to be conducive to success where brooders are employed.

Wet Mash Feeding.—Should this method be adopted the following plan will be found reliable. For the first week a mixture of hard-boiled egg and stale bread crumbs, moistened with a little sweet milk, should form the feed, but after the

third day the quantity of egg can be decreased and biscuit meal given instead. Under this system the secret of success is to feed often and only a small quantity at one time, removing any food unconsumed after each feed. For the first week the food should be given every two hours, commencing early in the morning and giving the last meal as late in the evening as possible. When the egg is dispensed with a variety of soft foods can be employed, and the mixtures given on p. 3 are all suitable. At this time feeding every three hours will be ample, continuing thus until the chickens are a month old, when the last feed at night should consist of grain, for which Mixture B can be used. When eight weeks old the chickens should be fed as suggested under the dry system for birds of the same age.

Comparative Advantages of the Two Methods.—The former method effects a great saving in labour, for the mixture of grain may be scattered in the chaff litter in sufficient quantity to last all day, while great benefit accrues to the chickens from the exercise derived by scratching for the food. An important point, however, is that wet mash feeding tends to greater expansion of the crop than where dry food is used. For this reason, apart from greater power of forcing for early killing, fatteners prefer birds reared by the former method, stating that they are unable to cram the same quantity of food in the case of dry fed birds. It would hence appear desirable to rear stock and laying fowls on dry grain, and table chickens chiefly upon soft or moist food.

Supplementary Foods.—Two supplementary feeding stuffs should be mentioned, namely, green food and fresh cut green bones. The former, consisting of all kinds of young vegetation, should be given constantly under both systems of feeding. Nothing is better than lettuces, lucerne, cabbage leaves, young onions, turnip tops, and Jerusalem artichokes. Green bones are also valuable, but should only be fed in small quantities about three times a week. Hoppers containing grit, oyster shell and vegetable charcoal, should always be kept before the chickens.

Dry Mash Feeding.—A third method of feeding, known as the dry mash system, is advocated by some American poultry-keepers. It consists in keeping a mixture of dry meals in a hopper constantly before the chickens. This method need only be mentioned briefly here as it appears to have been only tested once in this country. In this case the chickens were fed for the first four weeks on dry food, as described above, and afterwards fed on dry mash from hoppers. The mash consisted of 20 lb. of bran, 10 lb. of toppings, 10 lb. of maize meal, 1 lb. of linseed meal, and ½ lb. of clover meal. A second hopper was kept filled with

granulated meat. The result* showed that though the cost under the dry mash method was greater than under either of the other systems ($8\frac{3}{4}d.$ as against $6\frac{3}{4}d.$) the chickens grew so much more rapidly that the cost per pound of increase in weight was less, namely, hopper fed, $3\frac{1}{4}d.$, and dry fed, $3\frac{1}{2}d.$ Further particulars as to hopper feeding are given below (p. 6).

Adult Feeding.

As already stated, it is advisable to give the fowls their liberty whenever possible, so that they may find natural food. The diet must be adapted to the conditions under which the birds are living, the ration differing according to whether the birds are in confinement or at liberty ; whether the season is winter or summer ; whether the adults are kept for breeding stock or for laying purposes.

Fowls require a larger percentage of heat-producing material in the food in winter than in summer ; birds in confinement require green food and animal food to take the place of the vegetable and insect food which they would obtain if at liberty ; and, lastly, birds kept for egg production can be forced without producing the bad results that accrue when stock birds are fed in a similar way.

As far as possible the food should consist of home-grown crops, augmented when necessary by purchased foods. The principal foods suitable for poultry are :—

Grains : Wheat, barley, oats, maize, buckwheat and dari.
Meals : Toppings, barley meal, ground oats, buckwheat meal, bran, pea meal and bean meal.
Green Food : Potatoes, turnips, swedes, mangolds, artichokes, cabbages, lucerne, and clover hay chaff.
Animal Food : Blood, cut green bones, granulated meat.

The following rations are suitable :—

(1.) *Stock Birds in Winter.*

Morning feed—Barley meal or ground oats } 2 parts
Bran ... ... 2 „
Bean meal ... ½ part
} Made into a crumbly moist mash by the addition of 1 part of blood and 2 parts of water.

If blood is not available it may be replaced by ¼ part granulated meat, the whole being mixed with water.

Evening feed—Wheat, barley, buckwheat and dari alternately.

(2.) *Stock Birds in Summer.*

Morning feed.—Barley meal or ground oats ... 2 parts.
Toppings ... ... 3 „
Cooked clover hay chaff ... ... 2 „
Bean meal ... ... ½ part.

Evening feed.—Oats or buckwheat.

(3.) *Laying Birds in Winter.*

Morning feed.—Barley meal ... ... 2 parts.
Toppings ... ... 2 „
Maize meal ... ... 1 part.

* *Journal of the Board of Agriculture*, January, 1908.

This is made into a crumbly moist mash with equal parts of blood and water; or ½ part of granulated meat or 1½ parts of cooked clover hay chaff may be used in place of blood.

Mid-day feed in open weather.—Half an ounce of fresh cut green bone should be given to each bird; in severe weather the addition of a little maize will be an advantage.

Evening feed.—Barley, or 4 parts oats and 1 part maize.

(4.) *Laying Birds in Summer.*

Morning feed.—Toppings	... ...	2 parts.
Ground oats	... ...	1 part.
Bran	... ...	1 „
Bean meal	... ...	1 „
Granulated meat	... ...	¼ „

Mid-day feed.—Half an ounce of fresh cut green bone three times a week.

Evening feed.—Wheat or oats.

Where birds have full liberty and are able to obtain an ample supply of vegetable and insect food, the blood, granulated meat, clover hay chaff, and bean meal, may be reduced in quantity, or omitted altogether in summer.

Birds kept in confinement will require green food in addition to the above diet. This should be given in the middle of the day and should consist of raw turnips, swedes, mangolds, artichokes, lucerne and cabbages.

It is difficult to state exactly the cost of feeding adult birds, but it may be taken that it should not exceed ¾*d.* to 1¼*d.* per bird per week, when the fowls are at liberty and in confinement respectively. The latter sum is probably correct in the majority of instances where the greater portion of the food has to be purchased.

Dry Mash Hopper Feeding.—In America the cost of labour is an important consideration, and everything that will reduce that cost is regarded with favour. In addition to rearing chickens upon dry mash kept before the birds in hoppers (*see* p. 5), the same system is used for laying stock, for which large hoppers, holding a fortnight's supply, are used. There is a trough below, into which the food automatically falls as that already therein is consumed, so that the fowls eat whenever they desire to do so and as much as they like. Where birds are at liberty it is found that the hopper food is subsidiary to what can be obtained naturally. An experiment* gave the results of using a combination of dry mash and grain, the latter fed in litter. The former consisted of one of the following mixtures :—

	Parts by weight.			Parts by weight.
Bran	2		Ground oats... ...	1
Toppings	1		Bran	2
Linseeed meal ...	½	or	Toppings	3
Maize meal	2		Barley meal... ...	3
Beef scraps	1		Linseed meal ...	½
Clover meal... ...	1		Clover meal... ...	1

* *Journal of the Board of Agriculture*, May, 1908.

The ingredients were well mixed, and had an albumenoid ratio of 1 : 3·4, costing at present prices about 9*s.* per cwt. Wheat and barley were fed in litter. During the winter months roots and green bone were also fed. The cost proved to be a little higher than where moist food and grain were used, and no increase of eggs compensated for the additional consumption.

Weights of Grains, &c.

When purchasing foods it is advisable to secure good quality in all feeding stuffs, with the exception perhaps of good tail wheat, which is preferable to the more floury samples. The following weights per bushel of the principal foods mentioned should be ensured :—

Maize	60 lb.	Barley meal ...	42 lb.
Dari	60 lb.	Toppings	32 lb.
Millet	60 lb.	Bran	17 lb.
Linseed	52 lb.	Wheat	63 lb.
Bean meal	50 lb.	Barley	56 lb.
Maize meal ...	47 lb.	Oats	44 lb.

It may be taken as a general rule that the proportion of indigestible matter is greater in a light sample of any grain than in a heavy one, hence the importance of obtaining these grains of good weight.

Feeding according to Weight and Age.—It may not, perhaps, be known to poultry-keepers in general that the older and heavier a bird becomes the less food it requires daily in proportion to its weight, so that unless the following table be adopted to some extent there will almost certainly be a serious waste of food where large numbers of birds are kept; and though these figures really apply only to such breeds as Brahmas, Cochins, Langshans, and in some instances to Dorkings, it will still be worth while to follow them, to a lesser degree, in catering for the lighter varieties.

*No. of Birds (roughly).	Individual Weight of Birds.	Daily Amount of Food required.
100	1 lb.	13½ lb.
50	2 „	10 „
33	3 „	8½ „
25	4 „	7 „
20	5 „	6½ „
17	6 „	5¾ „
14	7 „	5½ „
12	8 „	4¾ „
11	9 „	4¼ „
10	10 „	3¾ „

[**The figures are largely taken from Woll's "Handbook for Farmers and Dairymen."*]

It must, however, be distinctly understood that this table does not apply to birds put up for fattening, but only to growing fowls.

Methods of Feeding.

Whenever possible all wet mash should be cooked or steeped for some hours before being fed, for by this means the food is rendered more digestible. This is particularly the case with such substances as bran and clover hay chaff, as the percentage of fibre in these foods is considerable.

Soft food should always be given in troughs, and whatever is not consumed should be removed as soon as the appetite of the birds is satisfied ; if scattered on the ground a portion will be trampled on and wasted.

Hard corn should be scattered in the litter of the scratching shed or thrown out in the open on grass, so as to induce the birds to take exercise. In the latter case care must be taken to give a quantity in accordance with what the fowls will consume, or a great amount will be wasted.

Note.—Other Leaflets relating to poultry are :—No. 129 (*Winter Egg Production*); No. 167 (*Ducks and Duck Breeding*) ; No. 176 (*Poultry Fattening*) ; No. 198 (*Rearing and Marketing of Geese*); No. 201 (*The Marketing of Poultry*) ; and No. 229 (*The Breeding and Rearing of Turkeys*).

4, Whitehall Place, London, S.W.,
June, 1904.

Re-written, August, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 16 leaflets dealing with Poultry and Bees, their Breeding and Management, may be obtained from the same address, price 1d. post free.

Leaflet No. 115.

BOARD OF AGRICULTURE AND FISHERIES.

Coral-Spot Disease.

(*Nectria cinnabarina*, Fr.)

One of the most common and most generally distributed of British fungi is that to which the name of Coral-Spot Disease has been given. The first stage of the disease takes the form of bright coral-red warts, which are about the size of millet seed, and are thickly scattered over the surface of dead or dying branches of the tree attacked. These red warts are very conspicuous, and at one time this condition of the fungus was considered to be an independent plant, and was termed *Tubercularia vulgaris*. At this stage numerous and exceedingly minute spores are produced, and readily scattered by the wind or by insects.

At a later stage the coral-red changes to a rusty-brown colour. The surface becomes rough with projecting points, and a second form of fruit is produced. In many instances the fungus passes through all its stages on dead branches, and in such a case no direct injury will be done, but rather a certain amount of good consequent upon the hastened decay of the wood on which the fungus is growing. The indirect danger arising from its presence on dead wood is the possibility of infection of living plants by the spores produced. The earliest indication of disease caused by *Nectria cinnabarina* is the drooping and yellowing of the leaves, which soon die and fall to the ground. In a few weeks the bark becomes slightly shrivelled, and the characteristic coral-red warts appear on the surface. Death of the leaves, and finally of the branch, is due to the choking of the wood vessels by the *mycelium*, which cuts off the supply of water and food.

The fungus is remarkable for the great number of species of woody plants upon which it can grow and produce perfect fruit, being met with on all fruit and forest trees, excepting conifers, and also on various shrubs. Amongst plants especially susceptible to the attacks of *Nectria* may be mentioned sycamore, elm, hazel, apple, pear, and red and black currants.

Preventive Measures.

1. Whenever diseased branches are observed they should be removed and burned without delay, as, after infection, recovery is impossible, and any delay in removal permits the formation of spores and probable infection of neighbouring plants.

2. Fallen branches, stored pea-rods, poles, &c., are often literally covered with the bright coral-pink warts of the *Nectria*, and should then at once be destroyed.

3. When pruning, it is a wise precaution to protect every cut or damaged surface with a coat of gas-tar, and also to remove and trim the ends of branches broken by the wind or by other agency.

4, Whitehall Place, London, S.W.,
July, 1904.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 116.

BOARD OF AGRICULTURE AND FISHERIES.

Sleepy Disease of Tomatoes (*Fusarium lycopersici*, Sacc.).

Description, and appearance of Plants attacked.

The "Sleepy-Disease" of tomatoes, although known for some seasons in Great Britain, has acquired an increased importance among growers, owing to the extended cultivation of the plant in recent years.

The plant may be diseased inside when quite young, but the outward manifestations do not necessarily appear at once. The first indication that the tomato is affected is shown in the drooping of the leaves and their bad colour. If the root is split, the woody portion is seen to be of a dingy yellowish brown colour, which becomes more marked if left open for half a day. When the plant has been attacked about three weeks the lower portion of the stem is usually covered with a delicate white bloom of mildew. Eventually the stem is covered with patches of a dull orange colour, and becomes very much decayed. The disease can always be identified by a brownish ring just within the bark at the base of the stem or thicker branches of the root.

The disease is due to a fungus which flourishes in the soil and enters the plant by the root. During its development it passes through three stages, the first of which usually lasts about a week, the stem at the end of that time being much decayed and covered with a gelatinous mass. During the last stage the spores are resting and preparing to attack the young plants another year, or whenever a suitable opportunity presents itself. The plant can only be attacked by the fungus in the last stage of its existence.

Treatment.

1. It must be remembered in the first place that diseased plants never recover, and therefore no attempt to save the plant is successful.

2. As the disease grows inside the plant it is useless to spray with a fungicide.

3. As the resting spores of the fungus live and thrive in the earth and attack the plant through the root the disease must be attacked in that quarter.

It is therefore recommended that :—

1. All diseased plants should be uprooted immediately the disease is noticed, and should be burned.

2. The soil in which the plants grew should be removed and sterilised by heat, or mixed with a liberal allowance of quicklime.

3. If the disease appears in a glass house, every part of the house should be washed with a solution of carbolic acid and water (1 of the acid to 20 parts of water) after the soil has been removed.

4. If it is not practicable to remove the soil, it should receive a liberal dressing of gas-lime. This should be allowed to lie on the surface for ten days, and should afterwards be thoroughly incorporated with the soil. After this the soil should remain for at least ten weeks before anything is planted in it. It should be soaked with water once a week.

5. As much lime as the plants will allow should be mixed with the soil in which tomatoes are grown, more especially if they are grown in the same beds during successive seasons.

6. The infected soil from a bed should not be thrown out at random, but should be sterilised by admixture of quicklime, and care should be taken not to bring it in contact with tomato beds.

7. Only short-jointed sturdy plants should be used, and those should be fairly hard and the foliage of a dark bronze appearance. All spindly or drawn plants should be rejected.

8. The plants should be allowed plenty of air, light, and room for growth.

4, Whitehall Place, London, S.W.,
November, 1904.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 117.

BOARD OF AGRICULTURE AND FISHERIES.

Black-Leg or Potato Stem-Rot.

Description.

This disease, although known for some time on the Continent, has not been prevalent in Great Britain. There is reason, however, to think that it is spreading in this country. It is very destructive, and the loss caused by it in Germany is frequently 10 to 15 per cent., and sometimes 75 per cent. of the entire crop.

The leading symptoms of the disease are as follows :—The leaves wilt and turn yellow ; then they become shrivelled from below upwards, and finally die. If the underground portion of the stem is examined when the leaves commence to droop, its surface will be found to be more or less covered with brownish stains. This discolouration gradually extends up the stem, which finally becomes black and rotten throughout. The number of plants affected in a potato field varies very widely. Diseased plants may be found growing among perfectly healthy ones, but more frequently the disease spreads from one plant to another.

The disease is primarily caused by a bacterium called *Bacillus phytophthorus*, but as decay proceeds various kinds of fungi, *e.g.*, moulds, &c., assist in the completion of the work. The disease spreads with greatest rapidity during hot, damp weather, and is most abundant during the months of June and July. The death of the haulms at this early period of the season, especially in the case of late varieties, means serious loss, not only on account of the scanty crop, but because the tubers also become infected by the bacteria that have been washed into the soil from the rotten haulms.

Methods of Dealing with the Disease.

The following measures have been suggested by Dr. Otto Appel, who has studied the disease in Germany :—

(1.) Potatoes, as well as beans, carrots, turnips, cucumbers, vegetable marrows, sugar-beet, and mangolds, which are also susceptible to the disease, should not be cultivated for two years on land where the disease has occurred. (It has been experimentally proved that cereals are not susceptible.)

Explanation of the Figures,

1. Showing the disease in different stages of development on the haulm.
2. A slightly diseased tuber, the bacteria having entered through a minute wound at *a*.

(2.) Potato "sets" should not be cut, but the tubers should be planted entire.

(3.) Care should be taken to obtain seed from districts where the disease does not exist.

(4.) Lime, or strong nitrogenous manures, especially nitrate of soda and sulphate of ammonia, should not be used.

4, Whitehall Place, London, S.W.,
September, 1904.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of Application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

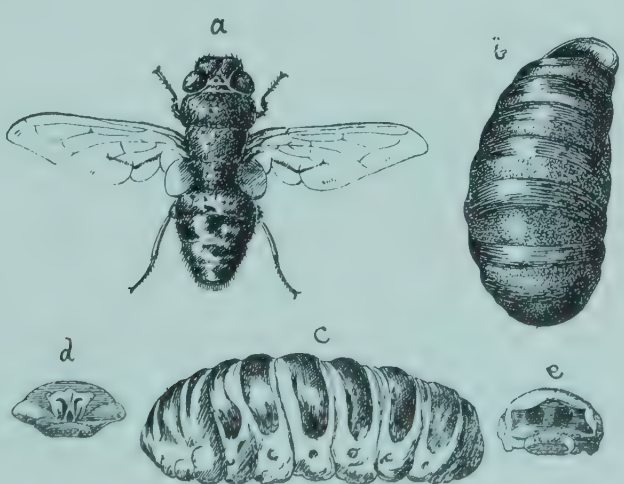
The Sheep Nostril Fly.

The Sheep Nostril Fly (*Oestrus ovis*) belongs to the family Oestridae or Bot Flies. The mouth parts of this species, as of the other bot-flies, are either abortive or rudimentary, so that as adults they do not feed. The harm is done by the larva or maggot which is parasitic on one of the higher vertebrates; in the case of *Oestrus ovis* the sheep is the host.

The Sheep Nostril Fly has a wide distribution, and the harm done by its maggots is known to flock-masters in Britain from north to south.

Description.

The Fly.—The somewhat hairy fly (Fig. *a.*) measures about half an inch in length; the upper surface of the head is light brown, and that of the thorax light brown or yellow to grey. Dark-coloured tubercles are seen on the thorax; the ringed abdomen is brownish yellow with dark spots; and the legs are brown. The wings are glassy, and extend, when the insect is at rest, beyond the body. The balancers (behind the pair of flying wings) are white, and are covered by well marked winglets. These winglets are present at the hinder margin of the flying wings.



THE SHEEP NOSTRIL FLY (*Oestrus ovis*): *a.* Fly; *b.* pupa case; *c.* larva; *d.* head end: *e.* tail end. (*a.*, *b.* and *c.* original and twice natural size; *d.* and *e.* after Ormerod, enlarged.)

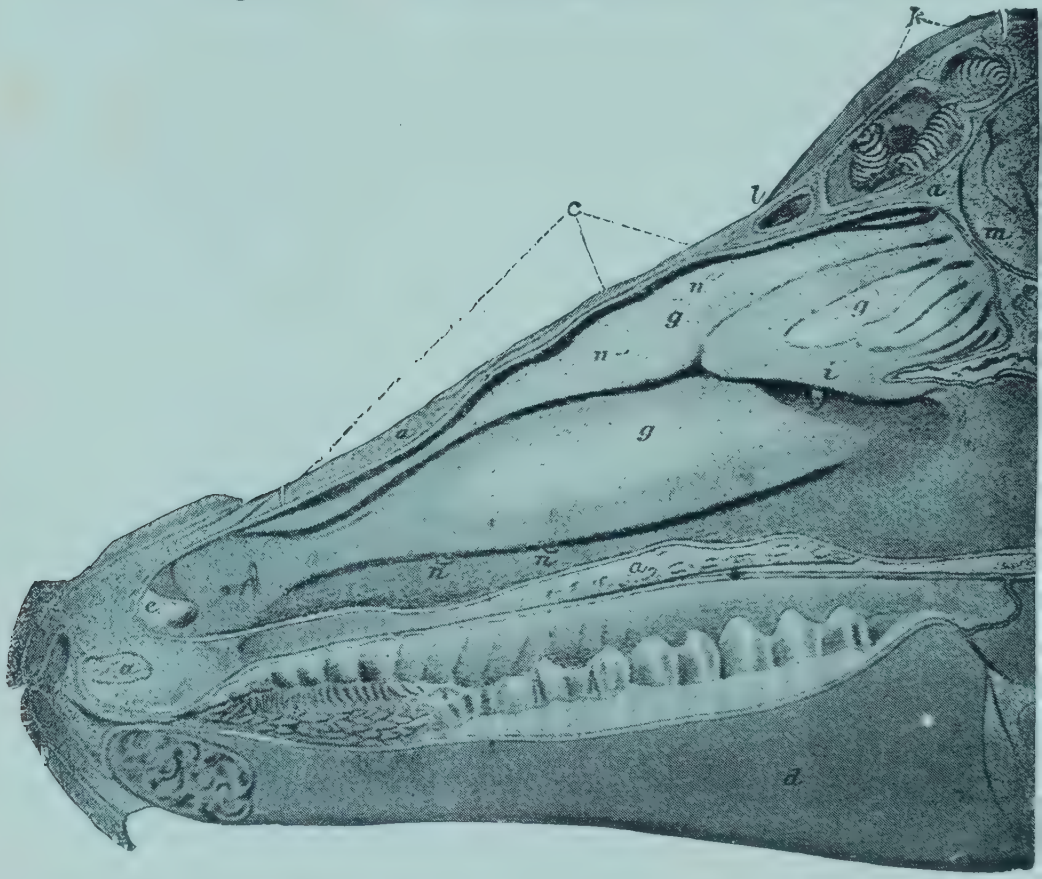
The Egg.—The eggs are somewhat curved or kidney-shaped.

The Larva.—The newly-hatched maggots (Fig. *c.*) are at first very small, white, and wormlike, but they become longer and

more rounded at a later stage. They have two hooks directed backwards at the head end, between which is the mouth. Along the under surface of the abdomen are transverse rows of little projections, and on the free end of the last segment are the spiracles or openings of the breathing tubes. Below these is a lobe with spines, and on each side a little process, both of which play their part in the movement of the maggot. The full-grown maggot measures between three-quarters of an inch and an inch.

Life History.

The flies leave their shelter places when the weather is sunny and warm. The sexes pair, and afterwards the females fly towards the sheep. Eggs may be laid round the sheep's nostrils as seen by Mr. Fred. V. Theobald, or live larvæ may be deposited in the sheep's nostrils. The maggots by their mouth-hooks, anal processes and spines, draw or push themselves up the nostrils (*e*). The pricking and wounding of the lining mucous membrane cause much irritation to the



Section of Sheep's Head invaded by *Oestrus* Larvæ (*after Curtice*).

attacked sheep. The larvæ feed on the secretions resulting from the irritation caused by their presence and their prickings, and they become mature in the frontal (*k*) and maxillary sinuses of the sheep. Ultimately, the full-grown larvæ return to the passages, and are sneezed out on to the ground. (Occasionally maggots wander into the recesses of

the turbinated bones [*g*, *g*], where they become imprisoned owing to increase in size, and ultimately die.)

The larvæ ejected from the nostrils pass the nymphal stage a little below the surface of the ground, under a clod, or sheltered in a tuft of grass. The fly matures and issues from the puparium during the summer, the complete development requiring about 10 months. The number of maggots in a head varies, but it is usually small. Maggots of very different sizes and in different stages of development may be found in the head at the same time.

The following quotation of Bracy-Clark's, from the Volume of the Linnæan Society's Transactions, for the year 1797, describes the behaviour of sheep when their enemy is at work :—"The moment the fly touches the nose of the sheep they shake their heads and strike the ground violently with their forefeet, at the same time holding their noses close to the earth, they run away, looking about them on every side to see if the fly pursues ; they also smell to the grass as they go lest one should be lying in wait for them. If they observe one they gallop back or take some other direction. As they cannot, like the horses, take refuge in the water, they have recourse to a rut, dry dusty road or gravel-pits, where they crowd together during the heat of the day, with their noses held close to the ground, which renders it difficult for the fly to get conveniently at the nostril." On occasion, however, the sheep may remain quite restful.

Symptoms attending infestation.

A discharge, which often agglutinates round the nostrils, is observed. The sheep sneeze in their endeavour to get rid of the larvæ. They toss their heads and rub their noses on the ground or with their feet. Sometimes they walk along with a high stepping gait and with their heads in the air. They may also exhibit difficulty in breathing from the obstruction of the air passages.

There is a loss of condition attendant on the constant irritation.

Treatment.

In combating the sheep nostril fly *prevention* is to be aimed at rather than later remedial measures.

1. Attempts may be made to deter the fly from laying its eggs or maggots by repeated dressings of the nostrils of the sheep, with such materials as tar or fish oil. As this is an onerous task, contrivances are employed for making the sheep dress themselves. These take the form of salting troughs made in the shape of the letter V, the sides of which are smeared with tar, and as the sheep lick the salt they get the tar on their noses. In other cases the boxes containing the salt are closed, save for a hole painted over with tar.

2. Where a pasture is known to be infested the sheep should be removed before the flies issue from the pupa cases.
3. Infested sheep should be isolated so that the maggots when mature may not be sneezed out on to the pasture.
4. To prevent further development the maggots when seen should be destroyed.

Remedial measures are not of much avail, and they may be too troublesome and expensive to be generally practised, save with very valuable prize sheep.

Such measures consist of fumigation to kill the maggots or induce a violent sneezing, which may result in the maggots being ejected Fluids which, if they reach the maggots, would kill them, may be injected up the nostrils. Cutting into the cavities where the maggots are resident, and picking them out has also been tried with fair success.

4, Whitehall Place, London, S.W.,
August, 1904.

Revised, July, 1906.

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BOARD OF AGRICULTURE AND FISHERIES.

Sturdy or Gid in Sheep.

The disease, known commonly under the names of sturdy, gid, turn-sick, &c., is caused by a cyst, or little bladder, called "*Coenurus cerebralis*," which develops in the nerve centres and more particularly in the brain.

The animals which most frequently suffer from it are lambs and shearlings; it is rarer in sheep over two years of age. The disease occurs occasionally in goats, oxen, and other ruminating animals. It is very rarely found in horses. The disease is, however, spread by other animals than these. The tapeworm, which lives in the small intestine of a dog, and is by no means uncommon in sheep dogs and sporting dogs, is the real source of infection.

The tapeworm is made up of a square-shaped head, with a long thin neck and a number of segments. These segments contain eggs, and when ripe they drop off. They are easily seen with the naked eye, being about half an inch long and one-fifth of an inch wide. They may go on increasing in number till the tapeworm is quite forty inches long. They fall off as they become ripe, and are passed through the bowel of the dog to the ground, and it may be on to the pastures where the sheep are feeding. They then decay, and the rain washes the eggs over the grass or into ditches or pools from which animals drink. These eggs die if they cannot get moisture. It is known that a fortnight's exposure in warm dry air will destroy them entirely, whereas even after three months' exposure on damp grass the eggs remain alive, and lambs pastured thereon have caught the disease by browsing the infected grass. This is one reason why sturdy or gid is more common in flocks which feed on damp pastures, especially when the spring and summer have been rainy, but it should be understood that moisture only acts by favouring the preservation of the eggs.

If swallowed by a sheep the eggs hatch out embryos with six hooks, which bore their way through the wall of the stomach or intestines and enter a blood vessel. They are eventually carried in the blood to the brain, spinal cord, and other parts of the body, but they only develop into fully-formed cysts or bladders in the two former. This cyst

gradually increases in size and brings about the symptoms by which the disease is usually recognised.

The cyst, which is the sole cause of "gid," is a little bag of variable size, and though originally very small, may in two or three months become as big as a hen's egg. Its outer coating is very thin, and it is more or less expanded by a clear colourless liquid. The parent cyst develops on its surface 100 to 200 little chambers like white spots about the size of a millet seed, and each contains the head of a future tapeworm. They cannot develop further till the sheep dies, and the brain or the part containing the cyst is eaten by a dog. When this happens each little worm-head is set free from the cyst by the digestive juices. It becomes fixed to the wall of the intestine, and grows for about $2\frac{1}{2}$ months, when the segments are passed out on to the grass in the manner which has already been described.

Symptoms.

A sheep affected with gid may be excitable, and very timid when approached, or it may be dull and stupid. Usually it is seen apart from the rest of the flock walking about unsteadily. Frequently it turns round in a circle. It is seldom at rest for any length of time and if disturbed may try to run away, but it can only move helplessly round in one direction, often with its head carried unevenly on one side. In advanced cases the sheep may become blind.

If the cyst exist in the usual place near the surface of the brain and on one side, the animal usually walks round to that side; if a cyst exists on both sides it may circle to one side or the other at different times; if it be situated in the fore part of the brain, the sheep raises its nose and walks straight forward, only stopping as a rule when it knocks up against something; whilst if the cyst is lodged in the back of the brain, the head is raised and the sheep stumbles forwards with a jerking uncertain motion of its limbs, breaking into a sort of shambling run ending in a fall and a violent struggle to get up. If there be several cysts in various parts, the abnormal movements vary.

In the course of time the affected sheep refuses to eat, and by the combined effects of starvation and almost constant movement it rapidly wastes away and dies. The sheep may live for about six weeks after the appearance of well-marked symptoms.

The cyst may be lodged in the spinal cord, usually at the region of the loins. In this case weakness and drooping of the loins is noticed. Eventually the sheep becomes completely paralysed in its hind quarters, which it cannot raise

from the ground. In such cases the animal may live for months.

Preventive Treatment.

1.—Do not keep more dogs than is necessary to tend the flock. In the spring time of each year, the dogs should be tied up for a few days and given a purge to expel worms. The object of tying them up is to see if any tapeworms are passed and if so to collect and destroy them by burning.

2.—The heads of sheep which have been affected with "gid" should be burned or boiled, and never left for dogs to eat.

Curative Treatment.

In consequence of the serious nature of the disease, and the frequently unsatisfactory results of treatment, nothing is, as a rule, attempted in the way of a cure, and affected animals are generally sent to the butcher. This is the least expensive course to adopt and usually the most satisfactory. It should be done as soon as distinct symptoms of gid appear, and the butcher should be warned to destroy the heads.

In exceptional circumstances, however, as when the sheep is of considerable individual value, operative treatment may be attempted. The operation consists in piercing the skull, and puncturing the bladder. It is desirable to remove the contents of the bladder, and as much of the latter as possible. Although the operation is sometimes performed with considerable success by intelligent farmers and shepherds, it is, on the whole, of such a delicate nature as to demand the services of a veterinary surgeon.

4, Whitehall Place, London, S.W.,
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Revised, September, 1905.

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Leaflet No. 120.

BOARD OF AGRICULTURE AND FISHERIES.

Peach Leaf-Curl (*Exoascus deformans*, Fuckel)

Distribution, and Plants attacked.

This disease, also known as "curl" or "leaf blister," proves very injurious to peaches and nectarines during certain seasons, whilst almond trees are also sometimes attacked. Occurring in every part of the world where these trees are cultivated, it is most abundant and destructive in humid regions, although not entirely absent from districts where the air is exceptionally dry.

Description, and Appearance of Plants infested.

The leaves and young shoots are the parts attacked by the fungus; on rare occasions the blossom is also infected. Diseased leaves become fleshy, much puckered and twisted or curled, and grow to a larger size than usual; the colour is at first a pale yellowish-green, often becoming more or less tinged with rose colour; finally, the upper surface of diseased leaves becomes covered with a delicate bloom, somewhat resembling that on a plum: this represents the fruit on the fungus. After the fungus has formed fruit, diseased leaves fall to the ground, this usually taking place before midsummer. Young shoots infested by the fungus become swollen and twisted or curved, and the internodes are very short; consequently the diseased leaves usually form a tuft at the end of a stunted shoot. When a branch is once infected, the fungus continues to grow in the tissues, and passes into the new leaf-buds formed each season. The appearance or intensity of the disease, even in the case of leaf-buds originating from infected shoots, depends almost entirely on prevailing climatic conditions. During a genial spring, when growth is unchecked until the leaves are full-grown, "curl" is practically absent; whereas if a cold, damp period occurs while the leaves are young, the disease at once appears, and its rapid spread is much favoured by alternating short spells of warm and cold weather.

Injury caused by the Disease.

The injury caused by the disease consists of the dropping of the fruit at an early stage, and the strain on the tree due to the growth of a second crop of leaves about midsummer, this second crop usually remaining free from disease. In

Peach Leaf-Curl.

the case of nursery stock, consecutive attacks for three or four seasons usually kill the tree, or stunt its growth to such an extent that it is practically valueless.

Sources of Infection and Remedial Measures.

In the United States it is contended that "curl" can be held in check by spraying with a fungicide alone; unfortunately, repeated experiments have proved that this is not true for this country. In the case of diseased trees, all the terminal shoots bearing infected tufts of leaves should be removed and burned; diseased fallen leaves should also be collected and destroyed. By removing the diseased shoots one source of infection, namely, that arising from the spores formed on leaves originating from these diseased shoots, is removed; besides, there is no advantage in retaining such contorted twigs on the tree.

A second source of infection depends on the presence of spores that have passed the winter in the angle formed between leaf-buds and the branch on which they grow, inside the bud-scales, or in minute cracks in the bark. Such spores should be destroyed by spraying with Bordeaux mixture, spraying to commence when the buds show the very first indication of swelling. Two sprayings, at intervals of ten days, if thoroughly well done, should suffice. The leaf-buds should not be sprayed after they begin to expand, or the foliage will be destroyed or injured.

The mixture should be made with 20 lbs. of sulphate of copper and 10 lbs. of lime to 100 gallons of water. The sulphate of copper must be dissolved in a vessel of cold water, and the lime, which must be pure and fresh, slaked in another vessel. The contents of the two vessels should be poured together into a tub and the proper quantity of water added. Sulphate of copper solutions are poisonous, and tubs, pails, or other vessels which have contained the mixture must not be used for other purposes.

4, Whitehall Place, London, S.W.,
November, 1904.

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BOARD OF AGRICULTURE AND FISHERIES.

The Construction of Pigsties.

The importance of having sound, healthy, and suitable housing for pigs is overlooked, or not understood, by a very large number of pig-owners, many of whom can least afford to waste their money by uneconomical methods. Many members of the working classes, and not a few farmers, by bringing up the animals in cold, damp, and dirty surroundings, are actually throwing away a great part of their labour and trouble, and even running the risk of losing the swine altogether. It is the foul, badly-built sty, which in bad weather becomes a quagmire, which harbours the germs of disease that too often spreads through the neighbourhood and cannot be suppressed for years. But even where no actual disease appears, all experience shows that swine kept under good conditions thrive better and fatten quicker than those kept in filthy surroundings. The labour and expense of building a good sty, and of keeping it properly, are repaid in a very short time.

Before laying down any rules about how to go to work, the different circumstances under which pigs are kept must be considered. Some pig-owners live in urban centres where ground is valuable and in demand, not only for gardens and allotments, but also for building houses. It is obviously useless to build an expensive sty on land which is likely to be used for other purposes in a short time. Other owners live in country places where land is plentiful, but building material scarce and troublesome to get. In such cases the owner must use what he can find. Sometimes stone is easily procured, sometimes bricks, and sometimes neither. The size and kind of pig-house must depend on the class of pig rearing that is practised in the district, and the plans must be adapted to meet the different requirements of breeding or fattening. If the pig-owner lives in a dairying county, a wheat-growing district, or a potato-growing centre, he must modify his plans to suit the wants and customs of such a neighbourhood; he must not think, for example, of putting a Large White Yorkshire sow into a sty which would be just suitable for one of the small breeds.

Points to be Observed.

In every case the man who sets about building a sty must aim at getting as much sunlight, fresh air, and dry footing as he can, and, if circumstances make it impossible for him to get all three requirements, he had better not build the sty at all.

The simplest way of dealing with the question of how to build useful, sound, and cheap housing for pigs is to begin with the case of the workman or labourer who, for varying reasons, has only need for one sty, and to lead up from this to a description of a more elaborate piggery where many swine—and those of all ages and sizes—are kept, and where the expenditure is a somewhat less serious consideration.

(1.) The most important part of every sty is the *Floor*, and every effort should be made to see that this is in all respects satisfactory, even if the rest of the building has to suffer a little. Swine can keep healthy and grow fat in a poor house if the floor is well made, but there is great danger of their pining and falling sick on a cold, damp floor even if they have a magnificent roof over their heads. A broken floor in which puddles of rain water or urine can lie is a breeding place for sickness and parasites of all sorts ; moreover, it gives the pig an opportunity of rooting, which he will generally be prompt to do, often not stopping till nearly the whole of the floor is upturned. The floor, therefore, must be made of some hard substance, which is not brittle, and does not too readily break up. The best material for this purpose is concrete or Portland cement, though a useful flooring may also be made with a mixture of tar and gravel, stamped and rammed into a solid block. Care must, however, be taken in this case not to let it be too long exposed to the sun's rays lest the tar melt and make the whole surface soft. Bricks cannot be recommended unless they are new and unbroken, and are laid in cement at least six inches deep, and even then they are liable to chip and crack. Stone flags are bad, as the manure sinks in between the joints and makes the soil beneath impure, while wooden floors, unless movable, are wholly to be condemned as dangerous and mischievous in the last degree. Concrete should therefore be used whenever possible.

The preparation of a concrete or cement floor is well within the means of every workman who can afford to buy a pig, and it is not difficult to make. It should be laid with a gentle slope towards the front of the sty, and it is advisable to make the top of the outer court lower than the bottom of the inner court by about two inches. There will thus be a small step between the two courts, which will enable drainage water to fall with a rush and run away more rapidly. The object is to secure dryness under foot, for, as has been already said, this is not only more healthy for the pig, but it helps to keep the floor from splitting or breaking away. Small channels should also be made in the cement before it has hardened, and these should run diagonally, in parallel lines, and not cutting across each other in the way that is termed cross-hatching. These diagonals or sloping lines should run from right to left on the inner court, and

from left to right in the outer court. The reason for this will be given later on. Before leaving this subject it is as well to emphasise this point :—The slope of the floor should not be so great as to make it slippery, lest the pigs on running out to their food should hurt themselves, and for the same reason the surface of the cement between the channels should be left slightly rough.

(2.) The next point to be considered is that of the *Walls*. These are too often made of wood, which is generally an unsuitable material, and should only be used when nothing better is to be obtained. Old planks and parts of packing cases or boxes are to be condemned, though railway sleepers (if in good condition and well bedded) are very serviceable, especially if an additional coating of tar is given to preserve them. Bricks, however, make the best kind of wall, and should be employed where possible if only for the lower part of the building. A wooden fence may be well built on the top of two or three suitably laid rows of bricks. The jointure of the wall and the floor should be carefully attended to, as, if moisture gets in, the floor may be broken and the whole work wasted. It is advisable, therefore, to add a little cement sill at the bottom of the wall to fill up the angle, and make the water run away into the channels. If bricks cannot be obtained—and there are many places where bricks are scarce—stone flags may be set upright, and made into a sort of paling. This is done in many parts of Lancashire. But if neither brick nor stone is available, and it is considered too expensive to build a concrete wall, wood must be used. In that case a sheet of zinc or iron should be screwed on the wooden walls inside the pigsty to preserve them from damp and from destruction by the pigs. Walls should be firmly built, and care should be taken not to build them so high as to shut out the light and air from the swine ; a few gaps may be left outside provided that they are small enough to prevent the entrance of rats. The gaps should not be so numerous as to prevent the walls being a protection against the wind and the cold.

(3.) The walls being built it only remains to add the *Roof*. This should be raised well above the floor of the inner court, leaving room for plenty of fresh air, without which the pigsty becomes very foul and liable to spread disease. The roof should, in fact, be high enough in at least one place to enable a man to stand up when he is cleaning the floor. This can be easily arranged in the kind of shed known as the "lean-to," which is the most popular form. The material of which the roof is made is of no great importance provided that it keeps out the wet and the cold. Tiles, slates, or thatch may be used, and in many parts of Yorkshire tarred brattice cloth is commonly employed. Iron, however, should not be used, at any rate alone, as it lets in

the heat in summer, and the cold in winter. A window is strongly recommended for the purpose of letting in light, and a pane of glass should certainly be let into the wall or the roof if a proper window cannot be built. It cannot be too often repeated that light, warmth, dryness, and cleanliness are necessary for the profitable keeping of pigs.

In the description that has been given it has been assumed that the inner court stands four square behind the outer court from the point of view of a person looking over the wall at the bottom of the sty. The entrance from the outer to the inner court should be on the left-hand side from the same standpoint, and the pig's bed, therefore, will be on the right-hand side, or the innermost part of the whole sty. A healthy pig seldom leaves any droppings or water in its bed, but in case any liquid should get there it is as well to make a small drain running straight from the place where the bed is put to the outer court, and so on to the bottom of the sty. The bed should be a very low platform of wood, raised just high enough to allow free ventilation, and should be covered with plenty of straw, bracken, or other litter, which should be kept fresh. If the sow is about to litter a piece of piping should be fixed a few inches from the wall to prevent her overlaying her young. The inner court may now be considered complete.

Drainage.

In the outer court the drainages should run down to the right-hand side, as already said, and that for two reasons. In the first place the pig's trough should be at the bottom of the sty, on the left-hand, in order that the pig may come straight out of the inner court to the food. This trough should be made of earthenware or iron and should be firmly fastened to the ground. Just over this trough should be a hole in the wall, with a falling door made of iron, so fitted that the pig's food can be poured straight into the trough without entering the sty. If this is thought too expensive, an earthenware pipe might be fixed in the wall, slanting at such an angle that all food poured in at one end must run into the trough. Care should be taken to keep the trough and the pipe clean and sweet. On the right-hand side, at the bottom, should be the gate leading into the outer court, and the drain should run straight down from the pig's bed to this gate, and this is another reason why the drainage should run to the right. But when collected there it should not be allowed to lie but should be led away by an open drain to a sump at some distance, far enough off at least to keep the sty fresh and clean.

The outer door must be strong; it would be a foolish waste to build good walls and then hang a rickety gate. It is only necessary to say that if it be of wood a plate of iron

or zinc should be screwed on to the inside to prevent its destruction by the pig. Some people advise a door between the inner and the outer court, but though advantageous, this is not necessary. If it is added it should be made in two parts, an upper which can be bolted at pleasure, and a lower which swings freely without quite touching the ground.

The above description applies to the building of a single sty, but more sties may be erected on the same model, side by side with each other, without any alteration. Each sty should have a separate drain as described above, and it is false economy to make one drain pass through all the sties, as is sometimes arranged. It is really dearer, for the sty through which the drain passes last is usually wet and unhealthy, and if disease breaks out in the top sty, all the swine are likely to be affected. An excellent method is to put the sties back to back, with a small gangway between, down which a man can walk, and from which he can see if the swine are faring well, or climb over the wall to clean out their beds. This plan has also the advantage that it gives more air to the inner courts of the sties. It is perhaps as well to add that if a number of pigs are kept in one sty the trough should be so arranged as to prevent the animals crowding one another.

If a really large number of swine are kept, it is very desirable that the piggeries should not be all together. It is advisable to have several sties in different parts of the farm, with separate sheds for the boars, the in-pig or farrowing sows, the stores, and the fat pigs. There should also be an isolation shed into which a pig can be put if noticed to be amiss or off feed for more than a single meal. It is a serious matter to get swine-fever into a valuable herd, and precautions should be taken at once to isolate the infected animal as well as to notify the fact in the way provided by the law.

4, Whitehall Place, London, S.W.,
November, 1904.

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Leaflet No. 122.

BOARD OF AGRICULTURE AND FISHERIES.

The Cabbage Root Fly (*Phorbia brassicæ*).

Fig. 1.

Fig. 2.

Fig. 3.

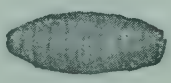

Fig. 4.

Fig. 1. Male Fly, greatly magnified. Fig. 2. Maggot, magnified.
Fig. 3. Last segment of maggot enlarged, showing tubercles.
Fig. 4. Puparium, magnified.
(Figs. 1 and 3 after Prof. M. V. Slingerland.)

This little fly is a grievous pest on cabbages and allied crop plants, both in Great Britain and in other European countries, as well as in the United States and Canada. It belongs to the family *Anthomyidæ*, a very large family of flies the members of which may easily be mistaken for ordinary house flies. There is a great deal of confusion as to the identity of this species; the attacks of other root-eating maggots have been attributed to it, just as the damage done by the cabbage root maggot has been ascribed to its relations.

Professor M. V. Slingerland has done very much to dispel this confusion,* both by making clear certain points in the biology of the pest and in showing how it may be combated with reasonable chances of success.

Plants attacked.

Attacked plants are checked in growth, and their leaves discolour, wither, and wilt, whilst infested parts become slimy, rotting takes place, and the plant falls away.

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* Bull. 78, Nov., 1894. Cornell Univ. Exp. Station. "The Cabbage Root Maggot," by M. V. Slingerland.

Phorbia brassicæ is truly an enemy to plants belonging to the natural order *Cruciferæ*, although there is an American record of the maggots mining the leaves of beet. The maggot has been found at work on the cauliflower, turnip and swede; cauliflowers in garden cultivation have been attacked, while Brussels-sprouts grown alongside and planted at the same time were unharmed. Attacks have also been recorded on broccoli, the radish, and the garden stock; and Slingerland found the maggots at work on such common cruciferous weeds as shepherd's purse, winter cress or yellow rocket, and hedge mustard.

Description.

The adult fly measures about $\frac{1}{4}$ in. long, and there are differences between the sexes. *The male* is dark ash-grey,

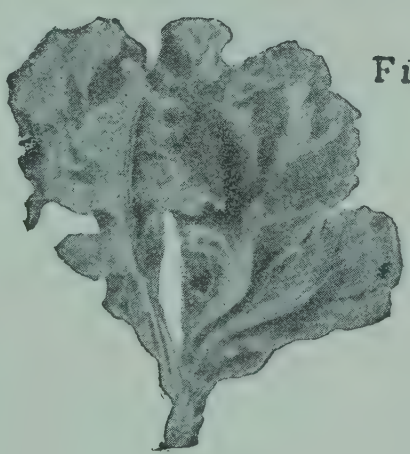

Fig. 5. Part of attacked cabbage, with larva *in situ*.
Fig. 6. Withered leaves of attacked cabbage.

and has three dark stripes on the upper surface of the thorax, a similar black stripe running down the abdomen, each segment of which has also a narrow transverse black stripe. The body generally is distinctly bristly. The eyes almost meet on the top of the head. The legs are black and bristly, and as a characteristic each hind femur (thigh) has at its base a tuft of bristles. *The female* fly is paler in colour; the dark stripes are fainter or absent; the eyes do not occupy so much of the head, there being a distinct space between them; and the abdomen is pointed.

The egg is very small but visible to the naked eye, whitish in colour, and narrow oval in shape.

The larva or maggot is white or whitish-yellow and legless; the head end is pointed, and has two dark curved mouth hooks; the hind end is truncate, and the last segment carries on its middle two dark spiracles. All round the edge of this last segment are 12 little projections, which can be seen on examination with a good lens, the two lowest being larger, and forked, the latter peculiarity being characteristic of the species. When full grown the maggot measures $\frac{1}{4}$ in.; it becomes a pupa under cover of its last moulted skin.

The puparium or pupa-case is light or dark brown in colour and oval in shape.

Life History.

The females lay their eggs close to the plant, choosing, it may be, a crack in the soil by which they can get below the surface, so that the eggs may be laid as near the plant as possible. In a week or more, according to weather conditions, the eggs are hatched, and the maggots first of all gnaw the external layers of the young roots, and then make and occupy galleries in the cortex of the main root. Sometimes the lower part of the stem is invaded, in which case the pith is tunnelled. In Scotland, several times, the maggots have been taken tunnelling in the leaf stalks of the swede. When full grown the larvæ pass into the soil a little away from the attacked plant, and become pupæ. Pupation may also take place in the infested plant. The first flies of the year appear for their egg-laying towards the end of April and in May, and there are probably three generations in the year.

Preventive and Remedial Measures.

1. Very early sown plants are noticed largely to escape; and temperature seems to be the important factor in this connection. Early setting out, however, is not always practicable, and even early planted cabbages may not escape attack.

2. Protecting the cabbages and cauliflowers by means of tarred paper or cards is a preventive measure which has met with success in America. The protection by this method was successful with 7,000 plants in one case and with 10,000 in another. Slingerland satisfied himself by experiment of its great usefulness, the flies not being able to get near enough to the protected plants for their egg-laying; presumably maggots from any eggs laid beyond the extent of the card are unable to reach the plants. The cards used are six-sided, about three inches across, with a slit reaching to the centre where there is a star-shaped cut to fit closely round any thickness of stem. The cards should be placed round the plants at the time of transplanting or setting out. To place the card in position, bend it slightly to open the slit, then slip it on to the centre, the stem entering the slit, after which

spread the card out flat and press the points, formed by the star-shaped cut, round the stem. A tool has been devised to cut these cards so that five to six hundred can be cut in an hour. The card must be put on carefully and lie close to the ground, so as to prevent the fly from creeping under to lay her eggs.

3. In garden cultivation, a cupful of paraffin may be added to a pailful of sand, and the sand sprinkled once a week round the stems of cabbages. This would act as a deterrent to the flies in their egg-laying.

4. In cultivation on a small scale, picking the maggots by hand from the plants, which have been taken up for the moment for the purpose, may be advantageously practised.

5. Badly infested plants should be removed and burned, the stumps being uprooted and also burned after attack so as to keep down the pest.

6. Carbolic acid emulsion and bisulphide of carbon have been mentioned by Slingerland as being successful insecticides for destroying the eggs, or, once they have got to work, for killing the maggots. The formula for the carbolic acid emulsion is 1 lb. of hard soap or 1 qt. of soft soap, dissolved in 1 gall. of boiling water, into which 1 pt. of crude carbolic acid is poured. This should be well stirred till an emulsion is formed. For use, dilute with thirty equal parts of water. This may be put on the plants so as to reach the eggs or maggots.

In the treatment with bisulphide of carbon (its fumes are poisonous, and it is also very inflammable, and hence no light must be brought near the substance) a little of it is injected into the soil near the plants, care being taken that the liquid does not touch the roots. The vapour diffuses through the soil and quickly kills the maggots.

7. Where the attack has been bad, neither cabbages nor beet should immediately follow, nor any cruciferous crop. Any rotation of crops which may be practised to evade the pest must be accompanied by the destruction of cruciferous weeds which play the part of nurseries for the cabbage maggot.

4, Whitehall Place, London, S.W.,
December, 1904.

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Leaflet No. 123.

BOARD OF AGRICULTURE AND FISHERIES.

The Shoot and Fruit Moth of Red and Black Currants.

Incurvaria capitella, Fab.=*Tinea capitella*, Cl.

Moth and Caterpillar (both magnified).

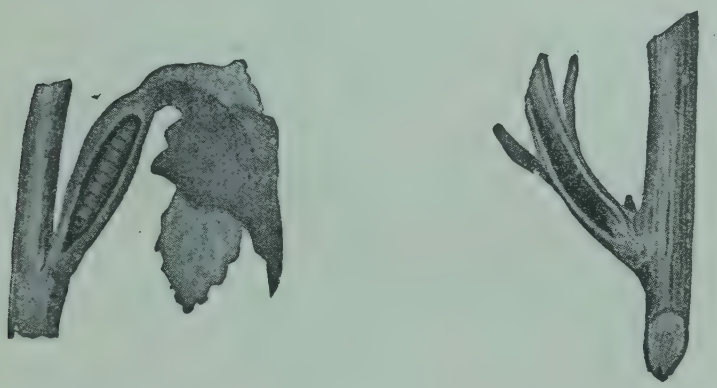
This little moth, which is not far removed in relationship from the Raspberry Moth (*Lampronia rubiella*), is one of a section of tiny moths, the members of which show considerable variations in life-history. The caterpillars of some species feed on the outside of leaves, others mine into leaves, while others feed at various stages of their life on quite different portions of the plant they attack. The caterpillars of *Incurvaria capitella* behave in the last-mentioned way, feeding in the young stage in the currant fruits, and completing their growth in the buds and young shoots. Attacks are chiefly recorded upon Red Currant, but in 1896 Miss Ormerod chronicled an attack on the Black Currant. The presence of the pest is revealed by the flower buds failing to develop, while young shoots droop, wither, and eventually die.

Description.

Moth.—The moth measures about half an inch in length, and over half an inch in spread of fore-wings. The head is deep yellow in colour; the fore-wings dark brown with a slight purple tinge. Less than half way from the base of each fore-wing is a pale yellow band running from the hind margin to the front margin; nearer the outside border on each fore-wing are two light yellow spots. The hind-wings are purple grey, while these and the outer margins of the fore-wings are ciliated, or very finely divided.

The moth has been found in North Ireland, and in England as far north as York and Manchester.

Caterpillar.—The young caterpillar on issuing from the currant fruit previous to its hibernating or resting state is extremely small (one-twelfth of an inch); it is reddish or greenish yellow in colour and has the characteristic 16 legs of a moth caterpillar; the four pairs of abdominal or middle legs are without hooks. The grown caterpillar—found in the buds and shoots—has hooks on the abdominal legs. The head is dark and the next segment has a dark plate, and there are hairs on the head and the various segments.



Shoot tunnelled by Caterpillar to the right, and Caterpillar in bored shoot to the left.

Life-history.

We owe our knowledge of the stages from the adult moth to the appearance of the caterpillar in the shoots to Dr. A. T. Chapman. The moths may be found in May flying in the neighbourhood of the currant bushes. The females lay their whitish lemon-shaped eggs in the young currant fruit. The mode of egg-laying is interesting. The moth chooses a currant and, resting on it, inserts her long ovipositor, or egg-lying tube, into the pulp and deposits the eggs near the seeds. Dr. Chapman believes two eggs to be left behind at each penetration of the currant by the ovipositor and thus more than one caterpillar may be found in a single fruit. The caterpillars on hatching feed on the seed. After feeding for a time, the caterpillar, though still very small and far from having completed its growth, burrows out of the fruit in June or July and spins a white case which is attached to the old persistent bud-scales or to the bark. With this protection the caterpillar enters upon a resting period which lasts into the next spring, when the partly grown larva leaves its case and bores into the buds, and also tunnels the young shoots. Here it renews its feeding and in April or the beginning of May completes its growth. The full grown caterpillar now passes into the chrysalis condition, and later the moth issues from the cocoon to proceed to pairing and egg-laying.

Preventive and Remedial Measures.

1. In order to destroy the caterpillars sheltering in their cases spraying should be done in winter with the emulsion-soda wash as recommended in Leaflet No. 70 (*Winter Washing of Fruit Trees*).

In connection with this Woburn soda-emulsion wash it has been found advantageous to make the emulsion with sulphate of iron and lime rather than with soap. The formula would then be :—Sulphate of iron, ½ lb. ; lime, ¼ lb. ; paraffin (solar distillate), 5 pints ; caustic soda, 2 lb. ; water to make 10 gallons. In order to prepare this wash the following rules should be observed :—(*a*) Dissolve the iron sulphate in about 9 gallons of water ; (*b*) slake the lime in a little water and then add a little more water to make it into a " milk " ; (*c*) run *b* into *a* through a piece of coarse sacking to keep back grit ; (*d*) churn the paraffin into the mixture ; and (*e*) add the caustic soda in the powdered condition just before using the wash.

2. Handpicking and burning the infested drooping shoots before the pests have escaped should be practised as a preventive against future infestation.

3. The Blue Tit has been observed feeding on the hibernating larvae. For an account of the Blue Tit *see* Leaflet No. 43 (*Titmice*).

4, Whitehall Place, London, S.W.,
November, 1904.

Revised, June, 1908.

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BOARD OF AGRICULTURE AND FISHERIES.

The Asparagus Fly, *Platyparea poeciloptera* (*Ortalis fulminans*).

a. Male. *b*. Female, both magnified (after Taschenberg).

This fly belongs to a family, some of the mature members of which have, as a characteristic, beautifully banded wings, whilst the maggots or larvæ have a boring habit.

Description.

Imago.—The Asparagus Fly is a small fly—the lines in the figure represent its actual length and spread of wings—with brown as the prevailing colour. The thorax, head, and legs are glossy brown, and the antennæ and face yellow-brown; the abdomen is brown-black, and shows at its hinder end four rather light transverse lines. The two wings, somewhat rounded at their ends, are marked by brownish zig-zag stripes. The body of the female is pointed and bears a well-marked ovipositor, whilst the end of the male is rounded. Both male and female are hairy.

Larva.—The larva is a roundish, glossy, and legless maggot, which is yellowish in colour; at the dark head end are two easily distinguishable gnawing mouth hooks; at the hind end, which is somewhat flattened, is a black-brown plate, to which are attached two hook-shaped or anchor-like processes. Full grown the maggot measures about half an inch.

Pupa.—The pupa is barrel-shaped; at first it is light yellowish-brown in colour, but later it becomes darker, and is slightly flatter on the under surface than on the upper; a short anchor-like double hook is at the hind end.

Life History.

The flies, issuing from early in April onwards until about the middle of July, lay their eggs beneath the scales of the

asparagus heads as these are appearing through the soil, or in the neighbourhood of the leaves on the already tall stems which are even approaching flowering.

In a few days—a fortnight to three weeks according to some authorities—the larvæ hatch out, and boring into the tender stalks and young shoots, feed in a downward course. The maggots working downwards, follow the longitudinal axis of the stem, their presence being marked by yellowish galleries or tunnels; these last are often too deep-seated to be seen without dissection. Pupation takes place from June onwards, according to the time of egg-laying, but is practically over by August. It is considered probable that there may be two generations in the year. The pupæ hibernate in the underground portion of the stem, often many together.

Symptoms and result of attack.

The affected shoots become brownish or yellow in colour and are stunted and decomposed, rotting finally below the ground, or at the point where they emerge from the soil. The affected stems occasionally show a bluish colour.

Treatment.

1. Where the area to be treated is small and easily examined, good results may follow if small rods, dipped in a sticky substance, are stuck in the ground early in spring. The flies will settle on these and be caught.
2. Collect the flies early in the morning when they are resting on the tops of the asparagus shoots.
3. Taschenberg recommends sprinkling the tops of the shoots, when the dew is on them, with powdered charcoal; this discourages the flies at the time of egg-laying.
4. During the summer all injured stems should be cut away with the asparagus knife and burned.
5. In autumn all remaining stem parts showing larval tunnels, and all dry stumps, should be deeply dug up and burned, so that injury in the next year may be lessened or prevented by the destruction of the pupæ.

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BOARD OF AGRICULTURE AND FISHERIES.

The Hessian Fly (*Cecidomyia destructor*).

Plants Attacked.

Wheat, Barley and Rye are the favourite food-plants of the Hessian Fly. There are also records of infestation on Timothy Grass and Couch Grass in Russia.

Description.

Adult.—The fly measures one-tenth of an inch in length. It is dark-coloured, with the abdomen reddish in fresh specimens; the wings are black or smoky-grey, due to their covering of hairs or scales; and the balancers are yellow-brown with black scales. The antennæ are long and many-jointed, with a whorl of fine hairs at each joint, and there are black scales on the long and slender legs. The male is somewhat smaller and more slender than the female and the slightly longer antennæ have the hairs more marked.

Egg.—The egg is glossy, and reddish in colour; it is one-fiftieth of an inch in length.

Larva.—The larva is a legless maggot, having thirteen segments including the head, and tapering somewhat both in front and behind. It is yellowish-white, with slight differences in colour and external appearance according to the stage of growth.

Puparium and Pupa.—The puparium, or pupa-case in which the pupa is enclosed, is the last moulted skin of the full-grown maggot; it is brown in colour and resembles a flax-seed in shape and size. The pupa, which is whitish, has a very delicate investing membrane.

Life History.

The eggs are laid, in May and June, in the furrows on the upper surface of the young leaves of the cereal; and a number of eggs may be laid on the same leaf. The maggots, which hatch in a few days, move from the place of hatching to their feeding place between the leaf-sheath and the stem of the plant; a favourite position being just above the second or the first joint or knot, on the stem. The infested plants become weakened by the loss of sap; and the affected crop may appear to have been severely weather-beaten, the stems becoming "elbowed," and bending over just above the place where the maggots are located. The length of the larval stage varies with the climatic conditions from less to more than a month. The full-grown maggot pupates at the place of feeding. The number of possible generations in the year varies with climatic and other conditions. There may possibly

be an issue of adult flies from the pupæ in the same year in Great Britain, but the issue to be feared is the one which causes the attack in the next year, at the end of April or in May.

Treatment.

1. When the crop is harvested many of the "flax seeds" or pupa-cases will be left in the stubble owing to the position of the infestation low down in the stem. The stubble should, therefore, whenever practicable, be burnt, or so deeply ploughed under that flies from the buried pupa-cases will be unable to reach the surface. All screenings and "flax seeds" that fall away in thrashing should be burnt.

2. The grain from an infested crop should not be used for seed. The value of the grain depends to a large extent on the reserve material stored up by the seed during the process of ripening, and plants stunted and weakened by attack will naturally produce poorer seed.

3. Fertilisers, especially in the case of a mild infestation, would prove useful in aiding the plant to tide over attack. Stout, coarse-stemmed varieties of wheat and barley should be grown, as they are less likely to "elbow."

4. Clover following a cereal crop is quite safe, as the Hessian fly does not attack clover, but flies from the "flax seeds" in the stubble may pass in a favourable season the following year to other cereal plants; in order to prevent such a contingency, the cereal crop might be sown without "seeds" so that the stubble could be ploughed in, or burnt, as suggested above.

5. Winter wheat should be sown as late as practicable, in order to avoid a possible attack by flies that may issue in the autumn

6. The Hessian Fly maggot is preyed on by a number of parasites belonging to the Ichneumonidæ, a family of Hymenopterous insects.

Although this fly is occasionally met with, it has not in recent years been the cause of any very serious damage, but in 1886 and 1887 the insect became somewhat widely distributed throughout Great Britain, twenty counties in England and ten in Scotland being affected.

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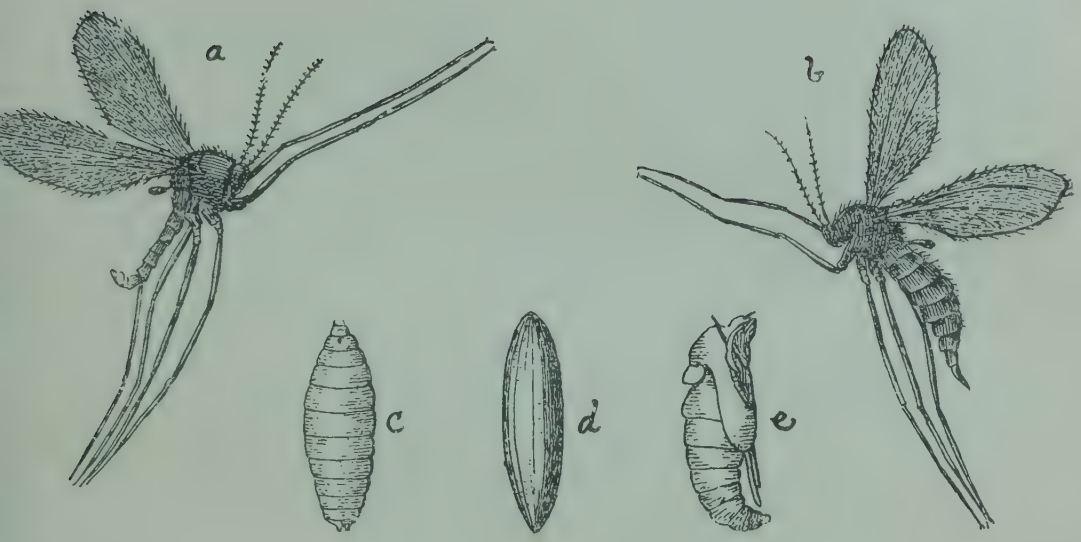
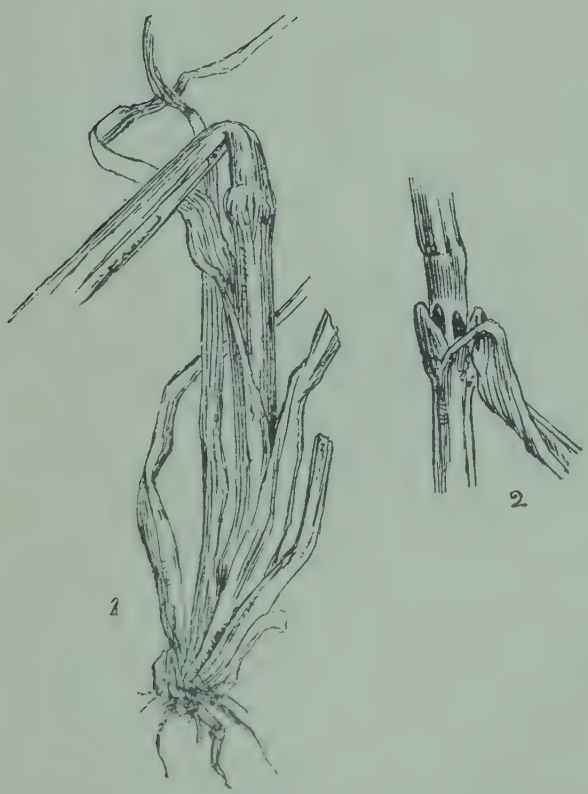


HESSIAN FLY.—*a.* Male ; *b.* Female ; *c.* Larva ; *d.* Puparium ; *e.* Pupa. All much magnified. (*b.* after Ormerod.)

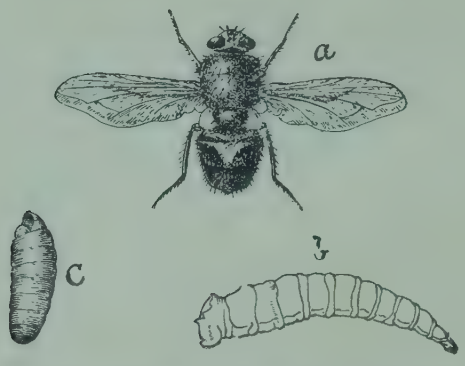


1. Barley stem "elbowed" by Hessian Fly larvae. 2. Showing position of puparia, or so-called "flax-seeds" (after Ormerod).

Leaflet No. 126.

BOARD OF AGRICULTURE AND FISHERIES.

The Sheep Maggot Fly (*Lucilia sericata*).



a. Fly; *b.* Maggot; *c.* Pupa Case Showing Place of Exit of Fly. (All twice natural size.)

Green-bottles (*Lucilia*) and Blue-bottles (*Calliphora*) are two genera belonging to the *Muscidae*, an important family of the two-winged flies. One of the green-bottle flies (*Lucilia sericata*) is a very prevalent cause of maggots on sheep, which, when attacked, show the following symptoms :—

(1.) Matting together of the wool fibres.

(2.) A continual wagging of the tail.

(3.) Rubbing and biting by the sheep in their efforts to allay the irritation caused by the maggots.

(4.) Much inflammation.

(5.) Oozing from the sores of an evil-smelling sticky fluid.

(6.) Discolouration of the wool, which falls out, and in bad cases does not grow again.

(7.) Rapid loss of condition.

Description of Lucilia in its different stages.

L. sericata is a bright shining green or blue-green fly, about one-third of an inch long, and about seven-eighths of an inch in spread of wing. The fly, examined with a lens, is seen to be covered with dark bristles, the arrangement of these bristles being used as an aid in distinguishing this and allied species.

The *eggs* are yellowish-white and measure about one-sixteenth of an inch in length.

The *larva* is a legless maggot, capable, however, of an active crawling movement. It measures, when full-grown, up to half an inch or more in length; the head end is pointed and provided with two mouth hooks; the hind end is blunt with tubercles round its margin and two plates carrying the spiracles on its flat surface. Examination, with a good lens, of the first segment behind the head, shows the spiracle to be fan-shaped and to bear ten little prominences. Professor Carpenter points out that a blue-bottle maggot would show in the same situation 13 such prominences.

The *pupa-cases* are brown and rounded or barrel-shaped, and the fly when ready issues by a hole at one end.

Life History.

The female fly is capable of laying as many as 500 eggs, and fixes these to the wool in clusters of 20 or more. These eggs may hatch in 24 hours, the resulting maggots feeding at first externally and later boring into the skin and flesh. In a fortnight they may be full grown, when they drop away from the sheep and become pupae under cover of the barrel-shaped cases. In certain experiments which have been carried out the flies issued in from less than a fortnight to over a fortnight, according to temperature and other conditions.

An attack is worse on lambs than on old sheep and the flies are found at work from May onwards until the autumn. Moist, warm, muggy weather, or warm sunshine after showers, favours the fly.

Loss.

Direct loss by death is infrequent where careful oversight by the shepherds is possible, such loss being most likely on hill pastures. Unfortunately, for some reason, maggots are now found at much higher elevations than formerly. Indirect loss is heavy owing to the disturbance to the flock caused by the frequent hunting and collecting. "Struck" sheep also thrive badly and are depreciated in value partly from this and partly on account of disfiguration.

Preventive Measures.

(1.) *Cleanliness.*—Sheep should be kept thoroughly clean about their hind quarters. A good measure is to clip the wool of the tail and between the hind legs. The purpose is to clear away any filth and to give as little opportunity as possible for lodgment, for the flies have a keen sense of smell

and are attracted to dirty places for their egg laying. Hence it is that sheep suffering from diarrhœa fall such easy prey to the fly.

(2.) *Destruction of Carcases.*—Carcases of all dead animals, including birds, should be burned or buried so that they may not serve as breeding places for the fly.

(3.) *Dipping.*—As a preventive measure dipping is useful, but as immunity does not last beyond a fortnight or so, the dipping must be repeated. Sulphur is regarded as an indispensable ingredient in any such treatment, the odour keeping away the fly. Carbolic dips are valueless for this purpose.

(4.) *Dressing.*—Dress the neighbourhood of wounds with some deterrent dressing, *e.g.*, an ointment of butter and flowers of sulphur, or spirits of tar.

Remedial Measures.

(a.) Infested sheep should be isolated.

(b.) The maggots are not difficult to kill. They should be picked or rubbed off, or where they have got to work the wool may be shorn a little, the affected parts being dressed with a mixture of turpentine and rape oil in equal parts, or with dilute paraffin oil, finishing off with a dusting of sulphur.

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BOARD OF AGRICULTURE AND FISHERIES

Sclerotium Disease (*Sclerotinia sclerotiorum*, Mass.).

Plants Attacked.

In the majority of instances parasitic fungi are limited in their attacks to one, or at most to a few kinds of closely allied plants. The species at present under consideration is however, a marked exception to this rule, and attacks many plants belonging to widely separated families. Among economic plants that suffer are potatoes, turnips, carrots, peas, beans, cucumbers, lettuce and marrows. Many kinds of weeds are also attacked.

Description.

An early indication of the disease is wilting and yellowing of the leaves, followed by drooping of the stem. When this stage is reached, the stem or leaves just above ground are covered with a whitish, fluffy mould, which soon changes to a brownish colour, and liberates clouds of minute spores when rubbed. This is the earliest and most frequent form under which the fungus appears and is called the *Botrytis* or summer stage. In potatoes, beans, &c., the mycelium or spawn grows up the inside of the stem and there forms numerous irregularly-shaped solid bodies varying in size from that of a turnip seed to that of a grain of wheat or sometimes larger. These bodies, known as *sclerotia*, are at first pale in colour, but become black outside when mature. They remain in this condition until the following season, when, owing to the decay of the host-plant, they fall to the ground, and produce spores which infect a new crop.

The fruit produced by sclerotia lying on the ground may be either of the *Botrytis* form, or, less frequently, may resemble a slender, long-stalked wine-glass of a clear brown colour.

Certain other sclerotium-forming fungi (*Sclerotinia bulborum*, Wakker, *S. parasitica*, Mass., &c.), attack bulbous plants, such as the onion, tulip, snowdrop, &c. In these instances the sclerotia are often formed in the scales of the bulb. The method of treatment is the same as for *S. sclerotiorum*, Mass.

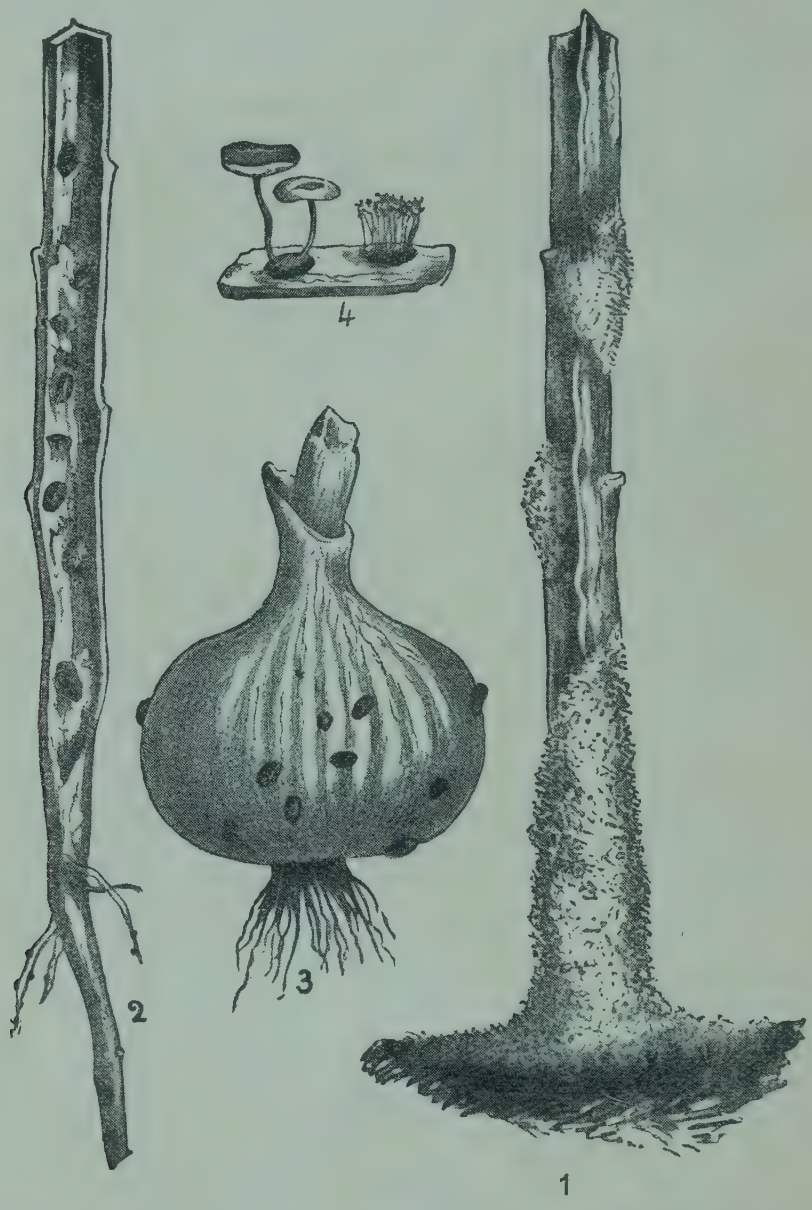

Fig. 1.—Portion of a potato haulm with the *Botrytis* form of fruit of *S. sclerotiorum* starting from the ground line.

Fig. 2.—Portion of a potato haulm split open, showing black sclerotia inside.

Fig. 3.—An onion with sclerotia of *S. bulborum* on the scales

Fig. 4.—The two forms of fruit of *S. sclerotiorum* springing from sclerotia.

Sclerotinia trifoliorum, Eriksson, one of the causes of "clover sickness" (*see* also Leaflet No. 46, Stem Eelworms) requires a special line of treatment.

Treatment.

The prevalence of the sclerotium disease is due to plants containing sclerotia being left on the land. The placing of such diseased plants in the piggery or on the manure heap does not destroy the sclerotia, which are capable of passing through the digestive tract of an animal without injury; in fact, they benefit by the process.

The following are some suggestions for checking the spread of this disease :—

(1.) Collecting and burning all infested stems, leaves, tubers or bulbs is the only certain means of destroying the fungus.

(2.) Accumulations of vegetable matter act as nurseries for the growth and dissemination of *Botrytis*, and should not be allowed in a garden.

(3.) Gas-lime or quicklime should be applied to land where the disease has existed.

(4.) Weeds also enable the fungus to tide over the time between crops of cultivated plants. Ornamental plants, such as Pæonies, Chrysanthemums, &c., are also attacked and may furnish spores that pass on to other plants.

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Leaflet No. 128.

BOARD OF AGRICULTURE AND FISHERIES.

Advice to Beginners in Bee-keeping.

The keeping of bees is much more frequent now than thirty years ago, when the fall in the price of sugar had nearly driven from the country markets the coarse honey gathered by the old straw skep system. This increase of bee-keeping has been chiefly brought about by the perfecting of the modern frame-hive, which enables the home of the bee to be laid open to view, and provides means whereby the stores can be taken, fit for immediate use, without injury to the bees or their owner.

First Steps.

One of the first steps to be taken by those desirous of becoming bee-keepers is to obtain a good book on apiculture, and to study it carefully. There are many books from which a choice may be made. It would also be advisable to join a County Bee-Keepers' Association, as in this way much advice and information can be obtained, whilst Secretaries of such societies will be able to furnish names of expert bee-keepers willing to render assistance if needed.

A personal explanation of the terms used and of the outfit required is a great help, and an interview for that purpose should, if possible, be obtained with an experienced bee-keeper.

Appliances.

The appliances required are: Black net veil; smoker, for subduing bees; wax comb foundation (brood and super); bottle-feeder; section boxes; and a frame-hive, fitted with brood-foundation in ten or twelve standard frames, two division boards, section-rack or lift of shallow frames, a queen excluder and quilts. If the hive is to be worked for extracted honey, a centrifugal honey-extractor will also be needed.

Additional useful articles are: Scraper-knife, for cleaning floor-boards, frames, &c.; comb uncapping knife, for use when extracting; a straw skep, for taking swarms; spare coverings of felt or carpet; and a super-clearer, for clearing bees from section racks or supers.

The Hive.

There are many patterns of hives, all made to take the one British Standard frame. A simple one should be chosen possessing accuracy of workmanship and soundness of material, so as to stand exposure to the weather for years. The outside of the hive should be thoroughly painted, to keep it rain and damp proof. It must be placed on its stand in a spot sheltered, if possible, from the cold north and east winds, and with a free flight for the bees in front. Space should be left behind it for easy access, so that all manipulations can be carried on from the back ; this avoids irritating the bees going to and from the entrance.

The Swarm and its Treatment.

The swarm should be ordered either from a recognised dealer or from a neighbouring bee-keeper. The safest way for a beginner to start is with a "head" or first swarm. By this means he will avoid all the pitfalls of disease or lack of condition, which only a practised eye can detect, but which beset the purchaser of second-hand stocks. Given a good season, a swarm should be able to establish itself, and provide some surplus for its owner, in its first year.

When the box or skep containing the swarm arrives, it must be placed in the shade near the hive the bees are to occupy. The screws of the lid of the box should be taken out ; or in the case of a skep the cording and wraps should be removed, and in the latter case the skep should be placed on a board, with a fair-sized stone under its edge, to allow of ventilation. The bees will soon quiet down, and cluster, after the shaking up of their journey, and thus will be in a condition for handling easily.

In the early evening the hive must be prepared to receive the swarm. The shallow-frame lift or section-super should be taken away, leaving only a thin quilt over the frames, which have already been fitted with brood-foundation. Then the front of the hive must be raised from the floor-board about an inch, by means of two wedges. Next, a board, the width of the hive, is placed in front of, and level with, the alighting-board, sloping down to the ground. This temporary board and the alighting-board are covered with a cloth hanging over the sides to the ground, to prevent bees from crawling underneath. Then the skep or box is taken between the palms of the hands, and carried mouth downwards, until it is just above the sloping board. With a smart jerk, the bees are thrown out in front of the hive, and they will at once begin to take possession of their new home. As they run in, watch should be kept for the queen. It is a satisfaction to see her safely enter her abode. When all are in, the wedges should be taken away and the front of the hive lowered to its proper place. Crushing of any of the

bees must be avoided. Any that are in danger may be cleared away with a feather.

If the swarm has been a long time on its journey, or if the weather is bad on its arrival, the bees will be greatly benefited by being supplied with half a pint of warm thin syrup, given through an opening in the quilt by means of the bottle-feeder.

On the second day after hiving, the quilts should be turned back from the ends of the frames to ascertain if the "foundation" remains properly fixed, and to see if the work is going forward well. If this is the case the quilt may be taken off and the queen-excluder put on in its place. Over this a lift of shallow frames should then be placed and covered warmly with a quilt and carpets. The stock may now be left alone till the end of the honey season. More skill is required for obtaining comb honey in sections in good condition, but the section rack may be used instead of the shallow frames, if desired.

Conditions conducive to Success.

It is important that the beginner should clearly understand the principles that underlie successful bee-keeping. A colony of bees consists of a queen, a large number of worker-bees, and (during summer) a certain proportion of drones. The strength of a healthy stock depends on the vigour and laying power of the queen, who is at her best in her second season, *i.e.*, a queen hatched in June, 1910, will be at her best in May, 1911, and should be replaced by a young one in 1912, either by natural swarming or by re-queening. Queens may be purchased, or raised by the methods described in text-books. The economy of a hive depends, *first*, on the keeping up of the warmth of the brood nest (by means of the heat evolved from the bodies of the clustering bees) to such a point as will stimulate the queen to lay eggs, and enable young bees to be reared; *secondly*, on the feeding of the queen, the nursing of the brood, and the cleansing of the cells for the queen's use; *thirdly*, on the collection of pollen, water, and nectar for the brood; and *lastly*, on the building of storage combs and collecting nectar for the future supplies of honey.

The first three of these conditions must be fulfilled before the last can be begun; therefore, it is only by means of a large and vigorous surplus population that a stock can gather enough stores for its future use, and provide also for the bee-keeper. *The aim of the bee-keeper is to keep his stocks strong*, for a weak stock is always unprofitable.

The next consideration is, that the crowded condition of the hive should be secured at the right time, *i.e.*, at the honey-flow. Honey is the concentrated nectar of flowers. Spring and early summer are the times when the land is

gay with a wealth of blossom, and the honey-crop is gathered. Late summer and autumn are times of seed and fruit, and only a gleaning of nectar from bramble and wild flowers then remains. There is a period every year, varying in each district according to soil and altitude, when the supply of nectar is most abundant. This time should be ascertained by the bee-keeper, who will then stimulate his stocks beforehand, so that they may have their largest population ready to gather the produce of the various flowers.

Diseases.

Diseases are best guarded against by having dry, weather-tight hives and vigorous queens, and by giving suitable food when feeding is requisite.

The following are the chief maladies to be apprehended :— *Dysentery*, a disease of adult bees, is caused by undue winter confinement, unsuitable food, and damp hives ; *Chilled-brood and Paralysis* are caused by sudden frost in late spring, or by untimely manipulation ; and *Bee-pest or Foul-brood* is a terribly infectious disease, endemic in many places in England. A description of Foul-brood is given in the Board's Leaflet No. 32. The Board would urge that the greatest care should be taken to eradicate this pest as soon as it is discovered.

A word of warning and encouragement on one other point must be given. One can seldom keep bees without being stung : the sting of a bee is painful but harmless (except in rare instances), and in time, after many stings, the effect is so slight as to be quite disregarded. It is advisable to wear a veil to protect the face and head, but the hands should be left bare. Their best protection is the gentle, careful manipulation of the bees while attending to them. Those who propose to keep a few stocks of bees only, may proceed in the manner outlined above : anyone intending to keep a large number of stocks is advised to get a season's instruction in a well-managed apiary before laying out capital in the business. In conclusion, it may be remarked that bee-keeping is an interesting and, to some extent, a profitable occupation, but it requires considerable patience and care, without which success cannot be attained. It is not always easy, moreover, to find a remunerative market for the honey.

The preparation of honey for market is dealt with in Leaflet No. 141.

The British Bee-Keepers' Association (Secretary, Mr. W. Herrod, F.E.S., 23, Bedford Street, Strand, London, W.C.) is the head-quarters of apiculture in Great Britain.

4, Whitehall Place, London, S.W.,
July, 1905.

Revised, February, 1911.

Leaflet No. 129.

BOARD OF AGRICULTURE AND FISHERIES.

Winter Egg Production.

The production of eggs is an easier matter in spring and summer, when the hen lays naturally, than is found to be the case in the depth of winter. There are, however, two reasons why the "egg farmer" should make every effort to secure the production of as great a number of eggs in winter as possible: (1) Because eggs are very much dearer in winter than in summer, and the profits for the year will therefore largely depend on the proportion of eggs which the hens can be induced to lay during the cold months, and (2) because in order to work up a sound business connection with consumers the producer must be in a position to supply his customers' wants as fully as may be all the year round.

Points to be observed.

To secure a good winter supply of eggs, the following points must be observed :—

(1) A good winter laying breed must be kept;

(2) The hens must be of a highly productive strain and bred, if possible, from several generations of good winter layers;

(3) The pullets which are to be kept for winter layers must be hatched neither too early nor too late;

(4) The hens must not be more than two years old;

(5) The houses and yards must be so laid out and constructed as to ensure comfort; and

(6) The food must contain a sufficiently large proportion of those elements which are necessary for the formation of eggs, the repair of tissue, and the production of heat.

It may be taken as a general rule that it is a good plan to allow the hens to hatch and raise one, two, or even three broods of chickens during the season when eggs are cheap. Time apparently lost in this way is made up for by the greater number of eggs produced when they are dearest and in greatest demand.

Breed.

No single breed can be said to be the best for winter laying, for a breed which will do best in certain circumstances may not be suitable in others. If, however, the different breeds are divided broadly into classes, the weight of evidence points to the conclusion that for winter laying the small non-sitting breeds are excelled by the heavy sitting varieties. The non-sitters will lay a greater number of eggs during the year, but the "general purpose" or sitting

breeds are better winter layers. Amongst the most popular of these breeds may be mentioned the Plymouth Rock, Wyandotte, Orpington, Faverolles, Sussex, and Langshan, and when kept under favourable conditions, fowls of any one of these breeds can be depended upon for a regular supply of eggs in winter.

Strain.

Strain is of as great importance as breed, and although this fact is well known to and utilised by fanciers, it is unfortunate that practical poultry-keepers in these islands have devoted so little attention to developing strains of specially good layers. The amount of useful work which might be done in this direction, is proved by what has been achieved by the great American egg farmers, who in a very few years have built up strains of hens whose laying capacities have been largely increased. Experiments which have been conducted in different parts of the world with "trap-nests," show that the average egg yield of hens can be materially increased in four or five years. The experiments consist in keeping individual records, by the use of "trap-nests," of the laying capabilities of large flocks of hens, selecting the best of these every year and mating them with cockerels raised during the previous year from pedigree layers. Bad layers may thus be eliminated from the flock, and by such a method the average number of eggs laid by the remaining hens must be greater. Further, by crossing the pick of these hens with cockerels bred from pedigree layers, there will be a further improvement in laying capacity in the next generation.

Seasonable Hatching and Rearing.

The farmer who desires to have a supply of eggs in winter must raise every year enough pullets to replace a portion of his old stock, and these pullets should be reared so as to lay at the opening of winter, say the end of October or beginning of November. The time of hatching depends very much on the breed which is kept, for some breeds, such as the Leghorn, Minorca, Ancona, or Hamburg, start laying when about five months old, whilst pullets of the larger breeds do not begin until they are seven or eight months old. Pullets of many breeds, when hatched in January or February, commence laying in June or July and moult in October, and are thus spoilt for winter laying, but if they are hatched too late or if they do not belong to an early maturing breed, they cannot be induced to lay in winter. In most parts of the country early March is the most suitable time for the hatching of the heavier breeds, while April or even May will be best for non-sitting varieties.

Age of Hens for Winter Laying.

The most productive period in the life of hens is between the ages of six and eighteen months, and many authorities hold the opinion that it is best to get rid of laying hens at the age of one and a-half years and to replace them by six-months-old pullets. The majority of poultry-keepers, however, find it more remunerative to keep their hens until they are two and a-half years old, owing to the labour and expense which would be incurred if pullets to replace the entire stock had to be raised every year. The greatest profit is to be made during the first year, when the net earnings of a hen may be estimated at from five to six shillings, while in the second year they would not amount to more than three or four shillings. In the third year the profits would be very small, the bulk of the eggs being laid in spring and summer.

Housing in Winter.

The importance of providing fowls with suitable accommodation can rarely be over-estimated. The quarters that have served so well during the summer months are not suitable for winter use, but in moving fowls from summer to winter quarters the mistake which is frequently made at the approach of hard weather is to shut up the fowls too closely in ill-ventilated houses, thus rendering them unhealthy and unfit for laying.

A roosting house for winter use should be substantially built in a well-sheltered situation, with a solid foundation, a good dry floor, and walls and roof without cracks or crevices which would admit rain, dampness, or currents of cold air.

It should be well lighted and well ventilated, and to each bird a space of about ten cubic feet ought to be allowed. Since it is quite as important that the hens should be provided with adequate shelter in the daytime as it is that they should be comfortably housed at night, it is well to provide a large well-lighted open shed in which they may spend the day, instead of being forced, as they are on very many farms, to seek shelter on the lee side of a hedge or hay rick. Hens that mope and stand on one leg throughout the day will certainly not do much towards keeping the egg basket full, and these are habits which they must not be permitted to acquire. On the contrary, they must be induced to take exercise by every possible means, for the great value of exercise as a means of promoting winter laying is well known to practical poultry-keepers. The shelter shed should, therefore, also be converted into a "scratching shed," by keeping the floor well littered with such materials as chaff, mill-dust, loft sweepings, &c., and by burying or raking into this litter a large proportion of the unground corn which is fed to the hens every day. This plan promotes exercise and keeps the hens busy practically all day. A busy hen is a healthy hen and a regular layer.

Winter Feeding of Laying Hens.

No matter how strong the inherent instinct to lay may be, and it can hardly be strong in the depth of winter, the hen cannot produce eggs if she is not supplied with suitable food, and the question is what foods or combination of foods can be advantageously used to promote winter laying? The plan frequently followed of feeding with any grain or meal available, regardless of quantity or constituent elements, and without consideration as to position, nature of the soil, or other natural conditions, cannot conduce to the attainment of egg production in winter, which can only be secured by special effort on the part of the breeder. Without such effort hens will not under ordinary conditions come into profit until the regular season, which is in the spring months.

An important factor to which sufficient attention has not been paid hitherto is the bodily condition of the hens. To meet the demand upon the system in the colder months of the year, non-migratory birds are provided with fatty reserves, and until these are exhausted the ovaries are inactive. It is well known that fowls are naturally heaviest at the end of the summer, and that they are in their leanest condition at the commencement of the breeding season. To promote winter laying, therefore, the surplus fat must be got rid of, and this can be attained (1) by feeding upon limited rations strong in albuminoids and containing the minimum carbohydrates and fat, especially as regards the latter; and (2), by compelling the birds to exercise their bodies to the fullest extent. In corn growing districts where the birds are at liberty to roam the stubbles, no food need be supplied for three or four weeks after harvest. In fact, there is frequently at that time more natural food available than can be consumed by a moderate sized flock of hens, but the exercise obtained in finding such food compensates for any excess. Where the land is pasture, the hens will only need one feed per diem, and this should consist of grain, such as small wheat and barley, and should be given in the evening. At this season, however, the greatest care should be taken to compel consumption of the fatty reserves by the methods stated, and thus bring the birds into such a condition as will be conducive to egg production. To promote early moulting in yearling hens, an excellent plan during August and September, is to add twice a week to the soft food, about 20 per cent. of linseed, which has been simmered until it is in the form of a jelly, and to give in the drinking water a teaspoonful of sulphate of iron to each quart. Unless moulting takes place early laying will be delayed. But where the hens are of a sitting breed, nothing helps more than allowing them to rear a brood of chickens in the summer.

As soon as the cooler weather approaches, and this is the time when eggs advance rapidly in value, the older hens should be fed twice a day, not more. The morning meal should consist of barleymeal 2 parts, toppings or coarse thirds 1 part, bran 1 part. On alternate days this may be moistened with liquor consisting of equal parts of blood and water, and mixed with about three parts of steamed clover hay, which is chopped fine, and added with its liquor: if preferred green bone or desiccated meat may be substituted for blood and water. Where possible, the soft food should be cooked or steamed, or, failing this, it may be mixed with boiling water, but the clover hay must be cooked, as it would otherwise be indigestible. Of the food named, adult fowls should receive only a small feed, not sufficient to induce indolence, and they will at once commence searching for other food. Soft food should be given in troughs, but grain may be scattered on the ground where it is free from excrement. The evening meal may consist of wheat (small but good), barley, oats or buckwheat, and in very severe weather, when the birds have commenced laying, 1 part of cracked maize may be added. An occasional feed of kibbled blue peas will not be amiss in mild weather.

In the case of pullets approaching their first season of laying, the same methods of feeding should be adopted, except that they may have a full feed of soft food in the morning instead of a half ration. Young stock of every kind are more active, require a larger quantity of nutriment, and display much less tendency to lay on fat than do older birds. For these reasons they generally commence laying earlier, but to meet the demand upon the system they should be supplied more freely with food. It is true that they eagerly search for natural food, but, as they are still growing, the risk of a check would be considerable if they were insufficiently fed, and it is necessary to provide against any danger of this kind.

The recommendations made above are for birds at liberty during open weather.

When the ground is locked up by frost or covered with snow, and little natural food is procurable, the morning feed must be ample, and an additional meal, consisting of greenstuff, roots, and a little corn, is desirable during the day. Only, however, under such conditions is this necessary. Where birds are in confinement the morning feed must be sufficient to satisfy them; a little corn may be scattered among the litter or cut chaff at mid-day, and a good supply should be given in the same manner at night. Under such circumstances the scratching shed system, as already recommended, should always be adopted. Mangolds should rarely be supplied until after Christmas.

The Production of Tinted Eggs.

A point which is of some importance to poultry-keepers is that, in view of market value, brown or tinted eggs are more desirable than white ones. In some of the home markets the highest prices are obtained for eggs which have a tinted shell, and the best class of traders find that these eggs are constantly enquired for by their customers. In spite of the fact, which is perhaps generally acknowledged, that the colour of the shell does not affect the quality of the egg, the preference indicated above exists, and must be taken into account. It is therefore desirable to note which breeds produce eggs which will meet the requirements.

The breeds which produce tinted eggs are without exception sitters; and of the breeds which are commonly kept the following list includes those which yield eggs of the desired character :—Langshans, Cochins, Plymouth Rocks, Orpingtons, Game, Wyandottes, Brahmas, Faverolles, Coucou de Malines. In addition there are other breeds which are not kept for egg production, notably the Indian Game and the Malay. Of the varieties named the Langshan produces the most beautifully tinted egg, and this perhaps explains why that variety at one time attained much popularity.

Unfortunately some of the breeds mentioned lay eggs which are small in size, but in this connection it must be borne in mind that small eggs are more acceptable to the consumer if tinted than are larger white eggs. Hence it is that crosses are frequently made with a view to increasing the prolificacy, and at the same time securing larger size generally. This results in the shells being less highly tinted than would otherwise be the case, but much can be done by careful selection of the breeding stock to deepen the colour of the shell.

In crossing two breeds respectively producing white and tinted eggs it is necessary to depend chiefly upon the females for conservation of the tinted characteristic, and it is advisable that in such crossing the male only should be selected from the white egg producing races. The following crosses can be recommended both for the colour of the shell and the number of eggs produced :—

White Leghorn—Langshan.
Ancona—Langshan.
Campine—Orpington.
Minorca—Langshan.

These are given in order of merit. If the colour and size of the egg only be regarded, the last-named cross would no doubt be preferred; but both the Minorca and Langshan are

slow-growing and slow-feathering races, and to cross these two breeds confirms a weakness which is in itself objectionable.

White Leghorn—Buff Orpington.
Brown Leghorn—Buff Orpington.
Minorca—Buff Orpington.
Ancona—Buff Orpington.

Of these the best in size is the Minorca cross, but the White Leghorns are hardier and yield rather more vigorous chickens. One great advantage of the Brown Leghorn—Buff Orpington cross is that in the colour of the plumage there is greater uniformity in the chickens than would otherwise be the case.

A White Leghorn—Plymouth Rock cross is of great value, as both the parents are very hardy and active ; and although the colour of the eggs produced may not be so deep as in some of the crosses already named, yet it is sufficiently so to meet the market demands.

In the case of a Minorca—Wyandotte or a White Leghorn —Wyandotte cross the object is to ensure a larger size in the egg, because the Wyandotte, although a prolific layer, produces eggs which are distinctly small, and in crossing it is desirable to remedy this weakness. The cross between the Minorca and the Wyandotte would ensure a much larger egg.

One great advantage which all breeds producing tinted eggs possess is that they are in general better winter layers than the varieties producing white-shelled eggs, this being due to the fact that they are usually very good sitters and mothers, and so obtain a rest during the spring and summer months.

There can be no question that one of the chief points which the egg producers in this country have to keep in view is the increase of the winter output, and if in combination a greater number of tinted eggs of good size can be secured, a dual advantage will be gained.

4, Whitehall Place, London, S.W.,
February, 1905.

Revised, November, 1908.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained, free of charge and post free, on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Navel Ill and Joint Ill of Lambs.

This disease is met with, under such local names as Big Joint, Joint Evil, Schooley, in most parts of the British Isles.

Cause.

The disease is caused by the entrance into the system of the newly-born lamb, through its unclosed navel, of germs whose special function is the formation of pus or matter. It is possible, however, that germs which are not pus-forming, but which may cause serious illness in lambs, may also enter the system of lambs by the navel wound. These germs are widely distributed in nature, but are found in greater numbers and probably in a more virulent form on those spots frequently soiled by animals, such as farmyards, lambing yards, &c., than in the fields. For this reason a permanent lambing shed or a site for a temporary yard used continually is a more dangerous place than the pastures.

Symptoms.

The lambs are noticed a few days after birth to be moving stiffly and to be disinclined to walk or suck. They lie down continually, and with difficulty are got on to their legs. Their joints begin to swell, and often it is apparent that abscesses have formed on them—the hock, stifle, point of the shoulder and knee being the joints usually affected. In the worst cases abscesses form in different parts of the body (particularly the kidney and liver), and kill the lamb by exhaustion or by the poisons produced by the germs of the disease. Other germs which do not necessarily cause Joint Ill may give rise to blood-poisoning, and kill the lambs more quickly, with symptoms of brain trouble and diarrhœa.

Prevention.

Every outbreak on a farm adds to the number of these germs, and so increases the probability of future

attacks. On the other hand, if outbreaks are prevented, the germs become fewer in number.

1.—A site for lambing the ewes must be chosen as free from infective material as possible, and there is no doubt, other things being equal, that ewes lambing in the fields rear a greater number of lambs than those in temporary or permanent lambing yards. Shelter, if necessary, can be provided by strawed hurdles set up about the fields in the form of a cross, or arranged to break the prevailing winds. The lambing field should, if possible, be changed each year.

2.—The system in vogue in some counties of passing the whole flock of ewes, if a big one, through one lambing yard cannot be too severely condemned. A large flock should be split into as many divisions as convenience will allow; it is then possible to confine disease to the divisions in which it occurs. If the lambing yard system is adopted it is imperative that a fresh site should be chosen each year.

3.—All dead lambs and the membranes in which they are born should be buried promptly. Straw on hurdles and for bedding should be renewed occasionally, and hurdles should be lime-washed. Manure and straw from hurdles should be placed in a heap, fenced off from the ewes, and should never go on to sheep pastures. At the end of the season the site of the yard should be sprinkled with lime and the hurdles lime-washed.

4.—Care should be taken that the shepherd does not carry disease from ewe to lamb or from lamb to lamb. A shepherd's hands must be continually and scrupulously cleansed with soap and water, while they must also be disinfected, nails being kept short and scrubbed with a nail brush. His clothes should be covered with a lambing coat which should be frequently washed. Dead ewes or lambs should not be skinned by the shepherd.

5.—A little disinfectant should be applied to the navel of each lamb immediately after birth. Stockholm tar has been found useful for this purpose.

6.—A ewe which has given birth to a dead lamb should not be allowed to run with the healthy ewes and lambs. If a ewe loses her lamb it is not safe in this disease to "mother" a fresh lamb on to her, as this lamb often becomes attacked. The expedient of putting the skin of a ewe's dead lamb on another to be adopted by her should on no account be resorted to.

7.—Ewes which have lost their lambs should be carefully watched, as it is possible that germs from the lamb may have found their way into her teats and produced inflammation of the udder, which, if it does not kill the ewe, will probably prevent the gland secreting milk in the future, and so render her unfit to breed again.

8.—The site of the lambing yard in which diseased lambs became infected should be immediately changed and the

hurdles re-strawed and disinfected. If a field is believed to be responsible, the sheep should be moved on to fresh ground. In this way it is possible to avert a serious outbreak.

Treatment.

If an outbreak should occur the attacked lambs, with their mothers, should be isolated on a spot not likely to be used for sheep for some time. If only a few lambs are attacked it will be found cheaper to kill them and dry off the ewes, as only a few attacked lambs grow into sheep which show a profit. If a large number are attacked, as many as possible must be saved, and it is then worth while employing a man to nurse them who does not go near the healthy flock. The symptoms should be treated as they arise. Bottle feeding will be necessary for the worst cases, and care must be taken that a lamb does not lie always on one side, as the limbs of that side are likely to waste or become paralysed.

4, Whitehall Place, S.W.,
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Leaflet No. 131.

BOARD OF AGRICULTURE AND FISHERIES.

Apple and Pear Scab (*Venturia inaequalis*, Aderhold, and *V. pirina*, Aderhold.

Description.

Although the fungi causing scab on apples and pears respectively are different species, they are very closely allied; but as the general appearance of the disease and the methods of treatment in each case are identical, separate descriptions are not necessary.

Scab is probably the most general and most widely distributed of fungus diseases attacking apples and pears, and

during certain seasons the entire crop is much depreciated in value, or rendered altogether unsaleable, owing to the presence of numerous blackish blotches or scabs and gaping cracks on the surface.

To the casual observer scab is only recognised on the fruit, whereas in reality the fungus appears first on the leaves and young shoots, from whence the spores are washed by rain on to the fruit, which is the last to be attacked. If the fruit is nearly full-grown before it is infected, the spots formed by the fungus remain small and are irregularly scattered over the surface.

Although the market value is thereby depreciated, such fruit is not materially injured, the scabs being quite superficial.

If, however, infection occurs when the fruit is young, its further growth is checked; the surface becomes more or less covered with scabs of various sizes, and at a later stage is irregularly cracked.

On the leaves and young shoots the fungus forms minutely velvety, dark coloured patches, which have an olive-green tint when the spores are ripe.

Treatment.

(1.) Spraying with half strength Bordeaux mixture (*i.e.*, 6 lb. of copper sulphate, and 3 lb. of quicklime to 100 gallons of water) should be commenced on the first appearance of the fungus on the foliage; if spores are once allowed to mature the case is practically hopeless, owing to their enormous numbers and rapid dispersion. The spraying should be done at intervals as found necessary until the apples are about the size of a hazel-nut.

Strong Bordeaux mixture must not be used, otherwise the foliage will be scorched.

(2.) When the disease has been present in an orchard all apple and pear trees should be thoroughly drenched with a solution of sulphate of copper—1 lb. of the sulphate to 25 gallons of water. This should be applied during the winter, before the buds begin to swell, otherwise the foliage will be completely destroyed. This winter wash is of great value in destroying fungus spores present in crevices in the bark, and should be regularly applied as a preventive.

(3.) The fungus tides over the winter in fallen diseased fruit; all such fruit should therefore be gathered and burned.

4, Whitehall Place, London, S.W.
March, 1905.

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Leaflet No. 132.

BOARD OF AGRICULTURE AND FISHERIES.

Slugs and Snails.

Slugs and Snails belong to a group of animals called Mollusca. The Slugs (or *Limacidae*) and the Snails (or *Helicidae*) are terrestrial in habits, and feed upon all manner of substances. The majority of snails prefer green diet, such as plants of all kinds ; many slugs also live upon plants, but others prefer dry vegetable and animal substances, and will not touch green matter unless under stress of circumstances.

During the last four years there has been a great increase in the number of slugs all over Britain, so much so that whole fields of cabbage, wheat, and other plants have been destroyed. In gardens they have been even worse, and it has frequently been impossible to grow a crop of early peas or beans. Young potato sprouts and flowering plants of all kinds have suffered in a similar way.

Slugs are unprotected by an external shell, but they have a shell nevertheless in the form of a small flat plate buried under the skin in the front region of the body. Snails, on the other hand, have usually a large shell into which the whole body can be withdrawn. They also have the power of closing this shell completely by means of a hardened plate which is spread over the opening into the shell.

These so-called molluscous animals have a mouth composed of external fleshy lips, and within there is an apparatus, the chief part of which is a ribbon-like mass of teeth, by means of which they rasp away the tissues of plants and other substances which they employ as food. Both kinds of these molluscs move by means of a flattened muscular part of the body called the "foot." One notable feature is the copious flow of slimy mucus these animals can produce, and, in the case of slugs, this especially interferes with killing them. This slime cannot be produced continuously for long at a time, but it is necessary to give two or three dressings of irritant powder before the skin is reached. Many different kinds of slugs and snails occur in Britain, some being injurious, others of no economic value, while a few are even beneficial. Both slugs and snails have male and female sexual organs in the same individual. Both deposit eggs, and the young resemble the adults.

Slugs.

The commonest slug is the *Grey Field Slug*, which may be found in every garden and field throughout Great Britain. It is one of the most prolific species of its race. A single individual is capable of laying as many as 500 eggs during the year. This slug resembles in general structure all other species. The body is long and rounded above, whilst the lower portion is flat and forms the so-called "foot." On the back will be seen an oval area which marks the site of the shell-plate hidden under the skin. A hole will be noticed at the edge of this area, this hole being the breathing pore.

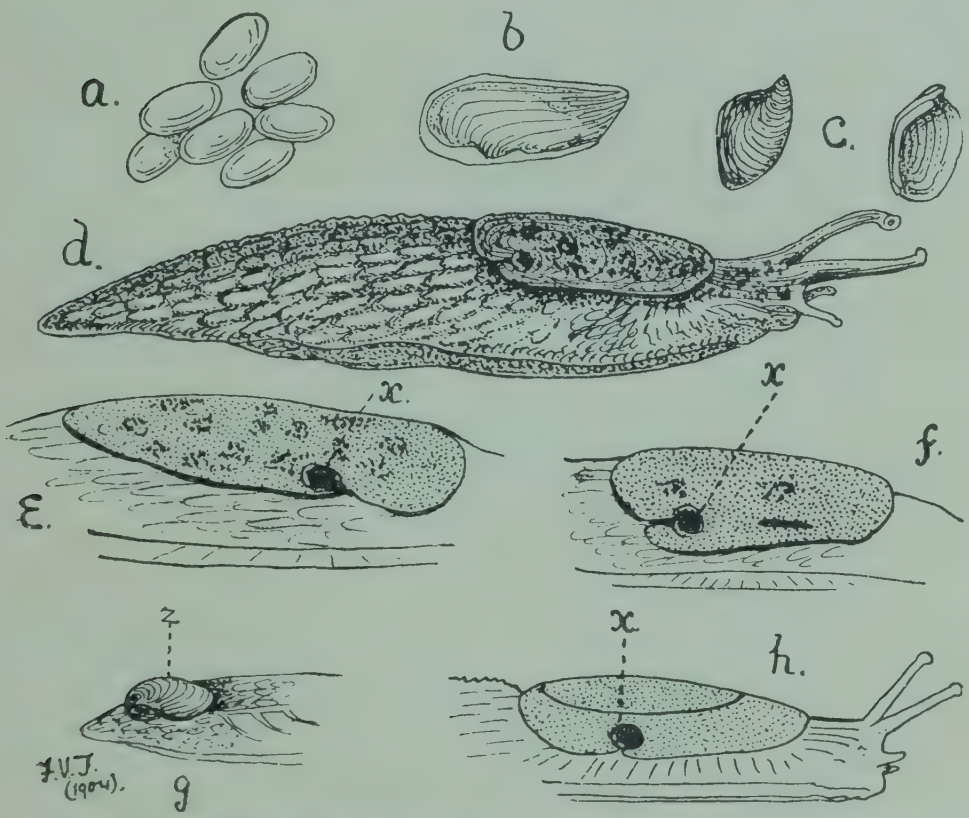

FIG. I.—CHARACTERS OF SLUGS.—*a.* Eggs ; *b.* Shell of Slug (*Limax*) ; *c.* Shells of *Testacella* ; *d.* Grey Field Slug (*Limax agrestis*) ; *e.* Shield showing respiratory pore (*x*) of an *Arion* ; *f.* of a *Limax* ; *g.* Tail end of a *Testacella* showing shell (*z*) ; *h.* Shield showing respiratory pore (*x*) of *Milax.*

The shell is a thin hard plate beneath the oval area, and in some kinds of slugs it is composed simply of a mass of granules. The head of the slug has not only fleshy lips on the mouth, and the rasping tongue within, but it also bears two retractile tentacles. The grey slug lays its eggs in the earth and under rubbish, &c., from May onwards into November. The eggs are round, milky, opaque bodies, and are deposited in batches of from six to fifteen. In from three to four weeks they develop into young slugs, which are like the mature mollusc, but very small and paler in

colour. When first hatched they are only one-twelfth of an inch long, and are very pale and soft. These slugs, like others, love moisture. They are chiefly nocturnal, and hide away during the day under stones, &c., and in the soil or under clods of earth when young. A shower of rain, however, soon brings them out during the day.

Slugs may be found at all times of the year, but in winter they usually take shelter under stones or logs, in the earth, and in rubbish heaps, where they remain in a semi-torpid state until the spring. Sometimes they occur even in mid-winter, when the weather is open. A small species, known as the *Bulb* or *Root-eating Slug*, passes the day under the ground, and comes up at night to feed on the leaves of plants. Like the earth-worm, this slug pulls down leaves into the ground and feeds upon them during the day, as it also does upon any roots or bulbs near it. A large *Black Slug* is also often noticed in gardens. This belongs to a different group to the Grey Field Slug; the breathing-hole will be noticed to be in front of the area over the rudimentary shell, and not behind it. The Black Slug may reach four or more inches in length. It is commonly found in gardens, damp woods, and along dykes; it seldom occurs attacking field crops. Like all slugs, it is very variable in colour, and produces a large quantity of slime.

Some slugs do not reach maturity for a year or more. They may then lay eggs and die. Others, as the Black-striped Slug, may live for four or five years. The *Yellow* or *Household Slug* is also a large species which is found in cellars, sculleries and dairies, and about doors. It feeds upon many substances, including meal and flour, and is very partial to cream. One finds it also on beer drippings in cellars. Of a dull, yellowish colour, it is often speckled with white and black, and has a bluish head and tentacles.

One group of slugs known as *Testacella* are worm-killers. These may be recognised by the small shell being external. They hunt and destroy earth-worms and grubs in the soil and may be said to be beneficial.

Snails.

Snails are all provided with shells into which the whole body of the mollusc can be retracted. Like slugs, they move by means of a flattened muscular area, the foot, and have a similarly formed head and mouth. They also produce much mucous slime. Damp and dark places suit some, whilst others occur on dry "down-sides" and sandy heaths. Like slugs, also, they are mainly nocturnal, or work during dusk, but they also appear in great numbers during the day, after showers of rain. They feed upon all manner of vegetation, although some kinds show a decided preference for certain food plants. As in slugs the male and female

organs are borne by the same individual, but they seldom fertilise themselves. They mostly feed above ground and so can be more easily destroyed than slugs.

The *Large Garden Snail* is one of the most widely distributed species and is that most often complained of in gardens. It is the largest garden species easily distinguished by its brown shell marked with pale zigzag lines. Eggs are laid in small batches in the earth, about 60 to 70 in each heap. Snails' eggs are white, shining, globular bodies which hatch in about 15 days. The young snails have very thin, transparent shells and grow rapidly. At the approach of cold weather they come together in heaps amongst rubbish in rockeries and ferneries, amongst the exposed roots of trees, and at the foot of hedgerows. They often occur in

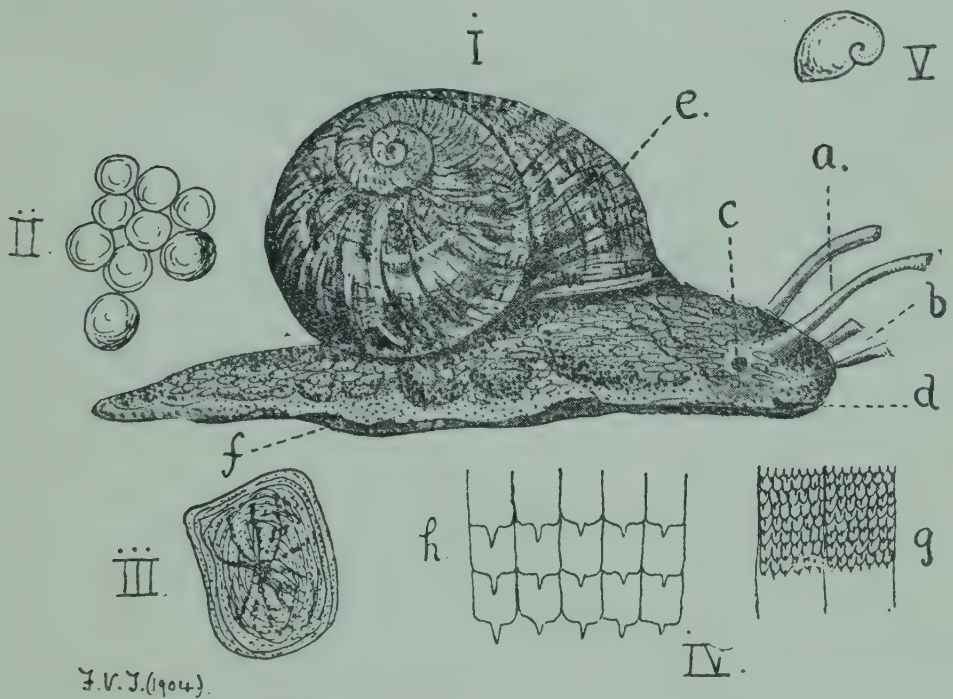

FIG. II.—THE GARDEN SNAIL (*Helix aspersa*).

I. Mature snail; *a.* large, and *b.* small tentacles; *c.* genital aperture; *d.* mouth; *e.* shell; *f.* foot. II. Eggs. III. Epiphragm. IV. Part of radula; *g.* a piece enlarged; *h.* teeth further enlarged. V. Young snail.

large masses united by the so-called epiphragms, which they form to close the mouth of the shell.

Clover, sainfoin and upland pastures are often attacked by the *Wood Snail*. This is one of the first to make its appearance in the spring. The shell is very variable in colour, being white, grey, pale yellow, pink, and brown, with one to five spiral brown bands and a black edge round the mouth.

The *Strawberry Snail* is a small snail, seldom more than half-an-inch long. It is essentially a garden pest and is particularly troublesome in strawberry beds and amongst violets. Iris and other garden plants are frequently ruined

by it. The shell is much more flattened in form than in the common large snails and is dirty-grey, reddish-brown or brown in colour, with numerous brown transverse streaks and a white spiral band around the last whorl. It occurs during the day only after rain, being a nocturnal feeder. The eggs are laid between August and November, and hatch in from 20 to 25 days. Each snail may lay as many as 60 eggs, either in or on the ground. They hibernate like the large garden snail.

In fields and gardens near the sea we find the *Small Banded Snail*, one of the worst culprits. It also occurs further inland and especially along "down-sides." The shell is conical and creamy white, with a single purplish-brown band above and others below. Snails of this species come out in great numbers during damp weather, and swarm over herbs and bushes. They never seem actually to hibernate. Wheat, mustard and field crops generally suffer.

Several other kinds occur in garden and field and do damage to plants.

Natural Enemies of Snails and Slugs.

By far the greatest natural checks are birds, especially the thrush, which not only eats many slugs, but is especially partial to snails, breaking their shells against a stone and picking out the mollusc. Blackbirds devour large numbers of slugs, as also do starlings. Toads are great devourers of slugs and small snails. Moles and shrew mice also help to keep down the number of slugs. Poultry and ducks eagerly search for them. Centipedes attack slugs, and ants frequently kill snails, but none of the foregoing save birds do any appreciable good in keeping down an excess of these molluscan creatures.

Prevention and Remedies.

The following may be mentioned as tending to prevent and lessen the attack of these pests :—

(i.) Drainage, because dampness favours them.

(ii.) Avoid long manure, or in fact any organic manure where slugs are abundant in the soil. Employ artificials *for a time.*

(iii.) Dry dressings of some irritant to kill the pests. (*a*) Soot and lime ; (*b*) salt and lime ; (*c*) lime and caustic soda ; or to act mechanically, (*d*) powdered coke.

The lime must be in a very finely-divided state and quite fresh. *Two or three dressings must be given*, the second some 15 to 30 minutes after the first. Lime and caustic

soda is found to act best—four parts of caustic soda to 96 of lime well mixed. Dry dressings, except powdered coke, should be applied very early in the morning.

(iv.) "Rings" of slaked lime or fine ash soaked in paraffin may be put round choice plants.

(v.) In gardens and hop plantations heaps of bran-mash or moist oatmeal may be placed here and there. These baits attract the slugs, which may then be easily collected.

(vi.) Heavy applications of soot are best to keep off snails, which should be dealt with mainly by hand picking and by trapping with cabbage leaves.

(vii.) Rows of peas, etc., are best protected either by spreading barley sweepings or cinders and lime along the rows, or by heavy dressings of slaked lime.

(viii.) Rockeries, ferneries, hedge bottoms, and rough herbage at the base of walls should be cleaned out in winter and the masses of hibernating snails crushed.

(ix.) Land that is thoroughly fouled with slugs should be treated with gas-lime and in the winter deeply trenched.

(x.) Wherever invasion is seen to come from a neighbouring copse or spinney a deep trench should be dug and filled with lime or tar, in order to trap the creatures.

(xi.) Ducks and poultry should be kept in hop gardens in late autumn, and ducks in spring, and also whenever possible the latter should be penned on garden land, as they greedily devour both kinds of pests.

(xii.) Thrushes should be encouraged. It is easier to keep them off our fruit than to suppress the snails and slugs which they largely devour.

4, Whitehall Place, London, S.W.
March, 1905.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 133.

BOARD OF AGRICULTURE AND FISHERIES

Powdery Mildew of the Vine
(*Uncinula spiralis*, Berk. and Curt.).

Description and Life History.

This destructive disease is caused by a minute parasitic fungus, which in the first instance is supposed to have invaded European vineyards from the United States, where it is commonly met with on both wild and cultivated vines. In its native country two kinds of fruit are produced by the fungus—the summer form, appearing as a white mildew on the foliage, and an autumnal form, in which the spores are enclosed in special receptacles, and remain in an unchanged condition until the following season. In this country the summer or mildew form of fruit only has been observed, and this was described by the Rev. M. J. Berkeley so long ago as 1845 under the name of *Oidium Tuckeri*. During the spring the fungus forms very delicate white patches on the upper surface of the leaves, and on young shoots and fruit; as the season advances these patches spread until, frequently, the entire surface of the leaf is covered.

The spores are formed in immense numbers, and remain on the leaf in the form of a white powder until scattered by wind, insects, spraying, &c. If preventive measures are commenced sufficiently early the disease is not difficult to check, but if spores are allowed to mature and become dispersed, success is by no means certain.

Treatment.

(*a*.) On the first appearance of small, scattered white patches of mildew on the upper surface of the foliage, every part of the plant should be sprayed with a solution made by dissolving one ounce of potassium sulphide in three gallons of water. Spraying should be repeated as occasion demands. Even in the absence of any evidence of disease, but more especially if the disease has previously existed in the neighbourhood, all vines should be sprayed. The first application should be made about a fortnight before the flowers expand, the second when in full bloom—care being taken at this time not to use too much force in spraying, in order not to injure the flowers. A third spraying may follow after an interval of three or four weeks if the mildew was present and has not been completely destroyed.

The use of a soluble sulphide for spraying, as recommended above, is preferable to the older methods of dredging with flowers of sulphur, or of placing sulphur on hot pipes. If spraying is properly done, the advantages are: (1) the greater certainty of covering every part of the plant with the solution; (2) greater cleanliness; and, (3) the avoidance of danger from too concentrated sulphur fumes.

(*b.*) The winter form of fruit, the use of which is to start the disease afresh the following season, has not been found in this country, and only on very rare occasions in any part of Europe; nevertheless the fungus possesses the power of living over the winter by means of mycelium which hibernates in the bark and buds of the vine. On the return of spring this mycelium produces the first crop of spores, which on being scattered over the young leaves, soon attain the proportions of an epidemic if not promptly checked.

To ensure the destruction of this hibernating mycelium during the winter, when the vine is resting, the trunk and branches should be thoroughly drenched with a wash consisting of one pound of sulphate of copper dissolved in twenty-five gallons of water. The soil, walls, glass, etc., should also be drenched with this solution, which, it is very important to remember, should only be applied during the winter, before the leaf-buds begin to swell, otherwise the foliage will be completely destroyed.

(*c.*) All diseased leaves and fruit should be collected and burned.

4, Whitehall Place, London, S.W.
March, 1905.

[OVER.]

Diseased Leaf and Grapes.

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BOARD OF AGRICULTURE AND FISHERIES.

Apple Culture.

The information given in this leaflet is not intended to be exhaustive, and in many respects may need some modification according to the general nature of the climate and soil of any given district. It is hoped, however, that sufficient information is given concerning the broad principles of apple culture to prove of substantial assistance to cultivators.

Situation of the Land.

If possible, the land selected should be well above the level of streams, but not so high as to be fully exposed to the prevailing winds. Land that slopes gently to the south-west and is sufficiently sheltered is best, if other conditions are favourable, as land inclining in this direction does not receive the full rays of the sun in the early morning before the temperature has risen, and the blossoms of the trees are, therefore, not so liable to suffer in frosty weather.

The Soil and its Preparation.

Land that will grow good wheat will grow good apples. Very light sandy soil should be avoided, as should also heavy clays. It is most important that the land should be free from weeds previous to planting the trees, as it is impossible to clean it after they are planted.

Draining.—If necessary the land should be drained, but this point may be decided by digging trial holes 3 ft. deep in various places. After a good rain the holes should be inspected. If water has collected in them the land must be drained, but if they are practically dry draining will not be necessary. If draining is to be done, 2-in. drains should be laid, making them about 2 ft. to 3 ft. 6 in. deep, varying the depth of the drain according to the nature of the soil. The drains on heavy land should not be so deep as those on a lighter soil. Very deep drains are not so effectual in carrying the surface water from heavy land. The lateral drains should be formed across the slope, if possible, terminating in a main drain of 3-in. pipes for an area of not more than four acres. If a larger area is to be drained, the main towards the lower part should be of pipes proportionately larger. The distance between the lateral drains should vary according to the texture of the land, but two lineal rods is a very convenient

distance, and is generally effectual in medium land; 15 to 18 feet will be more suitable for heavy land. The drains should, if possible, be so arranged that they are between the rows of trees, and they should all be perfectly straight. The lines of the main should be determined by slight angles if necessary. Curves must be avoided. The main drain should be slightly deeper than the laterals, the latter being connected with the top of the main.

Manuring and Cultivating.—The land being drained, the next step is to manure and cultivate it. It is a mistake to make the land very rich for young trees. They are not capable of taking up large quantities of plant food; indeed, if the land is too heavily manured, they develop soft and coarse wood which ripens imperfectly. Soil that will produce good crops of cereals will grow apples well if a moderate dressing of manure, say 20 tons per acre, is applied for the young trees, followed by additional supplies when they are carrying heavy crops of fruit. The land should be cultivated to a depth of at least 18 in., either by trenching, by sub-soiling, or by steam scarifying. The last named is the cheapest method for large areas.

Protecting the Trees.

Hedges of damsons may be planted around the area to protect the trees from the wind, but if the land is of a heavy nature, black Italian poplars may be substituted for the damsons. The poplars should be cut in close and topped every year, thus forming a very stiff wind screen. In very exposed places a double row of Scotch or Austrian pines will be found effectual, but these will require more room than the poplars. If standards only are to be planted, wire netting may be placed around each of the trees as a protection against rabbits, or against sheep if planted in grass, but if a mixed plantation is to be formed it will be preferable to enclose the whole area.

Selecting the Trees.

The trees should be selected during the latter end of summer. The ordinary standard is the most suitable if the land is eventually to be used for grazing purposes; but low or bush trees may be planted more thickly, while they also give quicker returns. If possible, the intending purchaser should visit the nursery and inspect the trees previous to purchasing, thus avoiding, to some extent, the risk of getting unsatisfactory trees. No hard and fast line can be laid down as to the exact varieties to plant in various localities, but great care must be exercised to obtain the trees on suitable stocks. The crab is, in general, the most suitable for standard trees, and the Doucin or broad-leaved Paradise for bush trees; but the very free-bearing kinds, such as Lane's Prince Albert, do well as bush trees on the crab.

Types of Trees.

Two forms of trees, viz., the standard and the bush, are generally used for orchard planting, either separately or together. The bush trees give quicker returns and produce finer fruit than the standards, while the latter last longer, and, in favourable seasons, produce large crops of medium-sized fruit. To form an orchard that will serve the double purpose, viz., give quick returns and last for a long period, it will be advisable to plant standards with bush trees between. Standards may be planted 27 ft. or 36 ft. apart, with bush trees between, 9 ft. or 12 ft. apart. The distance between the trees must be regulated by the space required according to their habit of growth. The bush trees will commence to bear the second season after planting, and may be expected to produce good crops until the standards grow them out; the latter will not fruit so quickly, but will in time produce large crops of useful fruit. The average quality of the past will not withstand the keen competition of the present, and, as the bush trees can be planted more closely, give quicker returns and produce fruit of finer quality and appearance than the average standard, the planter will do well to consider his line of action before purchasing. The matter may be summed up as follows:—

Standards give but small returns the first few years, but last a long time if properly managed, and, in favourable seasons, yield good crops of fruit; but the crops are often severely reduced by wind.

Bush trees give quick returns, the fruit is generally clean, good in quality and appearance, and larger than that of a similar kind grown on standards.

Standards and bush trees mixed give crops extending over a long period, the heaviest early crops coming from the bush trees, and a long continuous supply from the standards when once they are brought into a fruit-bearing state.

*Kinds to Plant.**

COOKING.

STANDARDS.	BUSHES.
Beauty of Kent.	Bramley's Seedling.
Bramley's Seedling.	Ecklinville.
Ecklinville.	Golden Noble.
Gascoyne's Seedling.	Lane's Prince Albert.
Grenadier.	Potts' Seedling.
Lord Derby.	Sandringham.
Lord Grosvenor.	Stirling Castle.
Newton Wonder.	Warner's King.
Wellington.	

Ecklinville and Wellington should not be planted as standards on heavy land.

* A statement showing the best varieties for planting for market purposes in different districts of Great Britain was published in the Board's *Journal* in April, 1908. (The *Journal* may be obtained direct from the Offices of the Board, price 4*d.* per month, post free.)

DESSERT.

Standards.	Bushes.
Adams' Pearmain.	Adams' Pearmain.
Blenheim Orange (slow to come into bearing).	Allington Pippin.
Christmas Pearmain.	Beauty of Bath.
Devonshire Quarrenden.	Christmas Pearmain.
Fearn's Pippin.	Cox's Orange Pippin.
King of Pippins.	Lady Sudeley.
Allington Pippin.	King of Pippins.
Worcester Pearmain.	Worcester Pearmain.

Planting.

October, or early in November, is considered the best time for planting, but the trees should not be removed from the nursery quarters until the ground has been well soaked with rain, or the roots may be materially damaged. To define the position of the trees various methods have from time to time been advocated, many of them taking up a considerable amount of valuable time. All methods aim at one common end—viz., to get the trees into their proper position, and it is an accepted rule that all newly-planted trees need staking. If a straight line is taken along one side of the proposed orchard, and another opposite, quite parallel, and one at each end at right angles, the four sides are defined. A stout, whitened stake should be placed at each corner. Stakes for sighting should then be placed at the distances apart that the trees are to be planted all along the four sides in straight lines. Three men should be employed, one directing from one of the base lines, another from one of the lines at right angles, the third to place the stakes to define the positions of the trees. If stakes suitable for the trees are used for this work, they may be driven into the ground firmly, and the holes dug around them for the trees. This method will avoid any further measurement or sighting. If standards are to be mixed with bush trees, care must be taken to place long stakes at the proper places.

The holes should be dug shallow and broad. Any damaged roots of the trees should be carefully pruned *from the under side* before planting, and the trees should be so planted that the roots are just below the surface of the soil. On land inclined to be wet, the roots may be slightly above the ordinary ground level in shallow mounds of earth. The trees should be secured to the stakes, care being taken to use straw bands to keep the trees secure yet quite clear from them, so that they do not get their bark chafed. Mulching with short manure should then follow, this mulching covering a space equal to the size of the hole before planting.

Pruning.

This matter needs careful consideration and much study to procure good results.

Standards.—Assuming that the trees were planted in autumn, they should be pruned the following February. The method of procedure may be as follows:—First thin out the weak, twiggy growths other than fruiting spurs (if any). Next

shorten the leaders—*i.e.*, the main growths. The weak leaders may be cut back to a point leaving about 4 in. of last year's growth, and the stronger growths at lengths varying according to their strength up to 8 in. If the trees are erect growers, they should be pruned to wood buds, pointing outwards (wood buds are pointed and fruit buds are larger and rounder). If they are of a drooping habit they should be pruned to wood buds pointing upwards. About the latter end of July the young trees should have their lateral growths cut back, leaving them about 2 in. to 5 in. or 6 in. long, some growers preferring to leave 5 or 6 leaves on the basal part of the shortened lateral, believing there is then less risk of sub-laterals breaking. Any laterals that are wanted as leaders to grow in large openings, to make the trees a good, serviceable shape, may be left. Those laterals that were cut back in July should be cut back again about the second week in September if the July pruning has not caused fruit buds to form; if it has, a second pruning will not be necessary. It is very important that the summer pruning should be done at the right time. If done too early, another set of sub-laterals will develop; and if done too late, when the leaves have fallen and the trees are void of sap, no good will result from the work, because there will be no sap for the formation of the desired fruit buds.

The following February the leaders should be shortened again. If they have developed a good supply of laterals the previous summer they should not be cut back so close as at the first shortening; but if they have not developed laterals freely, if their back buds are blind and dormant, they must be cut back harder than they were the first year. The second and third summer prunings should be the same as for the first season. The winter pruning for the third year may be lighter than for the second. The standards should by this time have formed good open heads, with their boughs well set out, and fairly stiff and rigid at the base. These boughs will in time develop into large ones, and their careful manipulation and distribution, when young, is therefore of more importance than is generally recognised. Subsequent pruning will be made to remove useless and unnecessary wood.

Bush Trees.—The pruning of the bush trees will continue in a similar manner, except that as the trees advance more length of the leaders may be left if they can properly develop their laterals. As the trees get larger, laterals should be allowed to grow as leaders where space permits. The trees should be encouraged to grow to a uniform height of 10 or 12 ft., keeping them as even as may be at the top, so that the wind may sweep along over them without moving the fruit-laden boughs to any great extent.

About five years after planting the roots should be pruned if the trees grow strongly or if blooming is unsatisfactory. The operation should take place after digging a trench

round the tree in October or November, and removing the earth so as to afford access to the roots; these should then be shortened back, *entering the knife on the under side*, leaving them when pruned half as long as the average length of the boughs—not counting the young growth of the current year. The hole should then be re-filled, and the tree mulched and staked. The second summer afterwards a good crop of fruit should be the result, and with proper care and attention the trees will go on fruiting year after year.

Manuring.

Sufficient plant food or manure should be applied to the trees to keep them in a healthy but not too vigorous state of growth. If they have a tendency to grow strongly, manure must be withheld, but if they carry heavy crops of fruit it is quite evident that the supply of plant food taken from the land by the trees must be replenished or failure will ultimately ensue. If necessary a dressing of 20 tons of farm-yard manure may be applied each winter, previous to cultivation, between the trees. The manure should extend as far from the stems as the boughs are long. Superphosphate and kainit are valuable plant foods for the apple, and may with safety be applied at the rate of from 3 to 5 cwt. each per acre, in addition to the farm-yard manure, if necessary. The amount applied should be regulated by the growth of the trees and the crops they produce.

Washing.

The trees must be washed in the spring, when the caterpillars of the winter moth* appear—usually about the time the buds begin to burst, from the middle of March to the middle of April. Older trees, infested with lichen, &c., affording protection for many pests in embryo during winter, should be washed about the middle of February† with a mixture made of

6 lb. caustic soda (98 per cent.),
2 gallons paraffin,
1½ lb. soft soap,
28 gallons water.

The soft soap should be dissolved in a gallon of boiling water; the paraffin should then be added and the mixture churned thoroughly until a cream-like mass results. (The thoroughness of churning is important.)

The 6 lb. of caustic soda should next be dissolved in the remaining 27 gallons of water, and then poured into the

* The methods of prevention and the washes recommended for use against the caterpillars of the winter moth are given in the Board's Leaflet No. 4. Among the other pests of apple trees dealt with in separate leaflets are Apple Blossom Weevil (No. 15); Apple Sucker (No. 16); Codling Moth (No. 30); Woolly Aphis (No. 34); Fruit Tree Beetle (No. 49); Canker Fungus (No. 56); Tent Caterpillars (No. 69); Brown Rot of Fruit (No. 86); Fungus Disease (No. 87); The Pith Moth (No. 90); Mussel Scale (No. 107); Apple and Pear Scab (No. 131); Apple Tree Mildew (No. 204); and Apple Sawfly (No. 205).

† Information as to winter washing of fruit trees is given in Leaflet No. 70.

paraffin emulsion. The whole should be well mixed and used immediately.

Sufficient whitening may be added to the wash at the time of spraying to define where the wash has actually been applied. This will ensure the whole of the trees being dressed.

Renovation of Old Trees.

The renovation of old-established standard trees is well worth close attention if they are good kinds. If the sorts are not of the best the trees may be headed down and good saleable kinds grafted on to them. Bramley's Seedling and Loddington will prove useful cooking kinds for grafting on trees of discarded varieties, while for dessert Allington Pippin and Worcester Pearmain may be used. If the trees are of good kinds, but impoverished, a dressing of 20 tons of farm-yard manure, together with 3 to 5 cwt. each of superphosphate and kainit, should be applied early in the autumn, and should be well dug in if the land is arable. If the land has been laid down to grass the same manures may be applied as a top dressing, but their action will not be so apparent as on cultivated land.

All useless boughs, particularly those growing crossways in the trees, should be removed. When the thinning process is completed there should be room for a man to move freely between the main boughs. The trees should be thoroughly sprayed in February with the caustic winter dressing previously advised.

*Packing and Grading the Fruit.**

Apples of the early kinds should be picked before they are quite ripe. They are not then so liable to bruise in transit as when quite ripe, and, moreover, they will ripen quickly when enclosed in the packages on the way from the grower to their destination; whereas, if allowed to become quite ripe, they would be softer, and would bruise far more freely in transit. The later kinds, that are to be stored, should be allowed to mature, or they will shrivel after they are picked.

The fruit is generally packed in bushel and half-bushel baskets, while some of the most successful growers use small barrels. These are better than baskets, as, the insides being smooth, the fruit does not bruise so freely. For the choicer dessert kinds light boxes may be used, in which case the lids should be fixed and placed downwards. The fruit should then be placed evenly upon what is then the lower part of the box, finishing at the top—which, when the remaining wood is nailed on and the box reversed, proves to be the bottom. The lid, which was originally the bottom of the box, is then at the top, and when removed exposes the carefully placed fruit to the eye of the purchaser. The boxes should be properly branded at the ends.

* Information as to the grading and packing of fruit and vegetables is given in Leaflet No. 98.

All fruit when packed should be carefully graded and sorted, so that only those of an even, uniform size are packed together. At least two sizes should be made from each bulk. Mixed fruit of various sizes is practically unsaleable, more particularly as the foreign supplies are so very carefully sorted as to size.

Storing.

For preserving late kinds until selling time a suitable store-house must be erected. Fruit will keep no better in elaborate expensive buildings than in an inexpensive building of thatch and earth. A very suitable building may be made as follows :—

Place a row of posts, about 4 in. square, in a line, 2 ft. apart, say for a distance of 100 ft.; then place a second row parallel, and 12 ft. from the first, inside measurement. The posts should be 5 ft. high from the ground line. Place boards along the outsides of the posts on either side and also at the ends, where suitable doors should be arranged. Dig a ditch on each side of the posts, 3 to 4 ft. from them, and place the earth against the boards. This will prevent the frost from getting in at the sides. Suitable plates and rafters may then be put on to the two rows of posts, thus making a span-roof building. The top may then be thatched with reeds, straw, or heather. The ends should be double-boarded, and the cavities filled with sawdust. A ventilator should be placed in the apex at the ends. The floor line inside the house should be slightly above the outside ground level, and, if possible, the building should be erected on a gentle slope. The inside may be fitted with three rows of shelves or benches on either side.

An inexpensive store-house may thus be erected, and the later kinds of fruit stored until selling time. Free ventilation should be afforded for a period of six weeks after picking the fruits to allow the moisture to exude from them. Afterwards the store-house may be kept closed, maintaining an average temperature of from 38 to 42 deg. Fahr., as nearly as possible, but sudden changes in the outside temperature will naturally have some influence upon that inside the fruit store.

4, Whitehall Place, London, S.W.
April, 1905.
Revised, June, 1908.

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BOARD OF AGRICULTURE AND FISHERIES.

Mange in Cattle.

Definition.

Mange is a contagious skin disease caused by parasitic mites or acari belonging to the family *Acaridæ*, a family which includes the mite causing Sheep Scab (See Leaflet No. 61).

Three forms of mange occur in cattle, viz., *sarcoptic*, *psoroptic*, and *symbiotic*. These forms are named after the species of parasite which is the cause of the ailment. Sarcoptic mange in cattle is uncommon. The most prevalent forms are the psoroptic and symbiotic, and these frequently exist together in the same animal. Cows are most often attacked.

Symptoms.

The most common sites of mange are the root of the tail and the neck, especially the former. If treatment is neglected the psoroptic form may spread all over the body, but usually it does not. The biting of the parasites gives rise to an itchy condition of the skin, which causes the animal to rub itself against fixed objects, with the result that the hair over the affected part gets rubbed off. On examining the skin a considerable amount of scurf may be seen. Red and yellow blood scabs appear on the surface, and there may even be abrasions if the animal has been rubbing against rough objects. If the psoroptic form should spread over the body the patient may waste away and become greatly reduced in condition. In cases of this kind, however, it will often be found that the wasting is due to some serious internal trouble such as tuberculosis, which reduces the animal's natural power of resistance to the less serious disease.

It has not infrequently been observed that cows appear to become cured spontaneously when turned out to grass in the spring. This usually means, however, that under open air conditions the parasites do not increase at the same rate, and hence the active symptoms are merely less marked. When the animals are again stabled in the autumn the acari (parasites) which have persisted resume their activity, and this sometimes leads to an erroneous belief that re-infection has taken place.

Remedy.

(1.) The affected patches on the animal's skin should be softened by washing with soap and warm water. After this has been done the parts should be dressed with one of the common mange dressings, such as spirit of tar, linseed oil, and sulphur. The dressing should be applied twice or even three times at intervals of ten days. In serious and rebellious cases veterinary advice should be sought.

(2.) The litter from an infected animal should be removed and burnt each time after dressing, and the flooring and wood or other fittings should be well sprayed with a five per cent. solution of carbolic acid in water.

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BOARD OF AGRICULTURE AND FISHERIES.

The Bulb Mite (*Rhizoglyphus echinopus*).

FIG. 1.
Adult Male, magnified 95 times.

FIG. 2.

Hypopus, magnified 100 times.

(Both figures after A. D. Michael.)

The genus *Rhizoglyphus* belongs to the family *Tyroglyphidæ*, a family of mites with a comparatively small number of genera and species, but a great number of individuals which may be found together in masses. Familiar examples of the family are the cheese mites, the hay mites, and a species which has several times been found swarming over furniture, curtains, &c., in houses. The family is interesting biologically, as amongst its members is found, in addition to the stages in the life-history of mites in general, the *hypopus* stage, this being a stage developed for the purpose of the spread of the species. Besides other differences, it is characteristic of the hypopus that it possesses suckers by which it can adhere to flying or passing animals, and thus be

conveyed to fresh feeding grounds. In this stage the mite is able to resist conditions which would be fatal to it in its other stages. All the individuals of the same generation do not pass through this hypopial stage.

There are two British species of *Rhizoglyphus*, viz., the Bulb Mite or Tulip Mite (*R. echinopus*) and *R. agilis*. The latter, discovered by Michael on decaying cabbage stalks in the South of England, is narrower in body, lighter in colour, and more active in habit than the Bulb Mite.

Food Plants of the Bulb Mite.

Rhizoglyphus (root eater) *echinopus* (spiny legs) feeds on underground swollen stems and roots, *e.g.*, the bulbs of the tulip, lily, hyacinth, onion, eucharis, and the tubers of the potato and dahlia, and can pass from one of these plants to another. It has also been taken in destructive numbers on the roots of the vine. This mite has been distributed all over the world in its food plants. Signs of infestation by the mite are :—

(1.) Checking of the plants, the leaves turning yellow.
(2.) Failure to produce flowers.
(3.) Reddish-brown spots on the scales of the bulb, indicating feeding places of the pest.

There has been some controversy as to whether the mites are really the cause of the failure of the bulbs. Some maintain that the decay of the bulb is due to error in treatment, *e.g.*, in Eucharis bulbs to over-forcing, bad drainage, faults in temperature or moisture, or shade, and that the decaying bulbs are then attacked by the mites. Michael, however, by many experiments, has placed it beyond question that the mites attack, and indeed prefer, sound bulbs, and they have been found at their destructive work in otherwise good tulip bulbs.

Description.

R. echinopus can be found in the stages of egg, larva, nymph, hypopus, adult males of two forms, and female. The adults have a smooth body, which is yellowish white in colour, and tinged with pink. The legs and rostrum are red. Each mandible ends in a pair of pincers, the branches of the pincers bearing three teeth. Just behind the second pair of legs on each side of the body is a projecting hair. There are four pairs of short thick legs, the two front pairs being the strongest ; the legs are five-jointed, bearing spines and hairs, and each ending in a single claw. The male has the abdomen more rounded at the end than the female ; the hind part of the cephalo-thorax in the male is as wide as the abdomen, but in the female it is not quite so wide. In one of

the two forms of male the third leg on each side is thicker, and is not used in locomotion. The hypopus carries on the middle of the under surface of the hind region a horny plate with twelve suckers; in front of this plate are two additional suckers.

The mites, which are extremely minute, need for their examination a good lens or microscope. There is very considerable variation in their size; Michael gives ·53 mm. for the male and ·55 mm. for the female as typical lengths for British specimens.

Life-History.

On hatching from the egg the larva bears six legs. After feeding for a short time this six-legged larva becomes inert and moults. The new form has eight legs, and is known as a nymph, and it is during this stage that the greatest growth takes place. In ordinary circumstances the nymph—according to Michael's experiments—probably moults twice, each moult being preceded by a sluggish period; the last moult of the nymph is succeeded by the sexually mature adult. Where, in the life-history of the individual, a hypopial stage appears, the number of moults is greater than the above. Larva, nymph, and adult do not greatly differ from one another in external appearance.

Treatment.

1. This pest is very difficult to combat because the extremely tiny mites feed not only on the outside of the bulb, but between the leaf scales of the bulb, feeding and laying their eggs in the interior, where they can scarcely be reached. The best plan is to burn badly infested bulbs, for the mites which have penetrated into bulbs cannot be reached. Infested soil should not be used for other bulbs.

2. In the case of mites which are more external the bulbs should be sprayed with paraffin, the treatment being repeated a fortnight later; or the bulbs may be washed in potassium sulphide (liver of sulphur), 1 oz. to 1 gallon of water, or brushed with this solution after removal of the outside scale leaves. This treatment is useful against fungi which follow the attack of the mite.*

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* At a meeting of the Scientific Committee of the Royal Horticultural Society (see *Gard. Chron.*, Dec. 20, 1902, p. 465) Mr. Saunders, in the course of a report on hyacinth bulbs containing a large number of *R. echinopus*, stated that "When bulbs are thus infested with these mites nothing can be done to save them. When only a few mites are at the base of the bulb, where the attack generally commences, they may be killed by immersing the bulbs for five minutes in water at a temperature of 115° to 120° Fahr. If some sulphide of potassium (6 ozs. to the pint) be added to the water, this remedy would be all the more efficacious; indeed it is said that soaking the bulbs in this solution cold for twenty minutes will kill the mites."

3. Infested bulbs may be fumigated with carbon bisulphide. The bulbs to be treated should be placed in an air-tight receptacle, and a saucer containing the bisulphide of carbon should then be placed on the top of them, and the receptacle closed. The bulbs should be left in the vapour for forty-eight hours. This treatment could be usefully extended to imported bulbs, which ought to be examined for the mite. The formula for fumigation on the larger scale is one pound of bisulphide of carbon to 1,000 cubic feet of space, more being used if the infestation be very bad or if there be some leakage. Bisulphide of carbon fumes are very poisonous, and should not be breathed, and no naked light (the operator, for example, should not be smoking) must be brought near them.

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BOARD OF AGRICULTURE AND FISHERIES.

Varieties of Scab in Potatoes.

There are several so-called "scab" diseases of the potato, some of which cause widespread damage to the crop. Wart Disease or "Black Scab," due to *Synchitrium endobioticum*, Percival, is dealt with in Leaflet No. 105; and Corky Scab, due to *Spongospora scabies*, Massee, is described in Leaflet No. 232. In the present leaflet it is proposed to give some account of three other forms of "scab," due, respectively, to the fungus *Oospora scabies*, Thaxter, to Millipedes (*Julus* sp.), and to mechanical injury.

Oospora Scab of Potatoes.—The scab caused by *Oospora scabies* is one of the most widespread of diseases affecting the potato. The fungus usually attacks the tubers while young, forming scattered rough patches or scabs on the surface; these patches gradually increase in size and number, and not infrequently when the tuber is full-grown its surface is more or less completely covered with scab. This scab is distinguished from the other forms by the presence of the parasite, which appears on the wounded portions as a delicate greyish bloom.

The injury is confined to the surface of the tuber, the skin being broken up into fragments over the diseased patches. Though the market value is much depreciated when *Oospora* scab is present in quantity, the quality of the potato is not in the least impaired for eating. The preventive and remedial measures which may be practised against this form of scab are :—

(1.) If scabbed potatoes are used for "seed" without having been sterilised, the resulting crop will almost certainly be diseased, and in addition the fungus will pass into the soil, where it is capable of living for several years. Scabbed potatoes may be used for "seed" without the slightest danger of spreading the disease if they are immersed for two hours in a solution consisting of one pint of commercial formalin (=formaldehyde, 40 per cent.) mixed with thirty-six gallons of water. The potatoes should then be spread out to dry, when they may be cut and planted in the usual manner. Great care must be taken after potatoes have been treated as above that they are not placed in sacks or hampers that have contained scabbed potatoes.

(2.) Land that has produced scabbed potatoes is certain to be infected with fungus, and should not be planted with potatoes for several years afterwards; beet, swedes, carrots, and cabbages are also attacked by the fungus, and should

therefore not follow a crop of diseased potatoes. Cereals may be sown with safety on infected land.

(3.) In the case of gardens and small allotments, where potatoes are of necessity grown every year, the trenches in which the potatoes are planted should be sprinkled with powdered sulphur.

(4.) Lime favours the development of the fungus in the soil; the same is true of stable manure, night-soil, &c. Acid manures only should be applied to land that is infected.

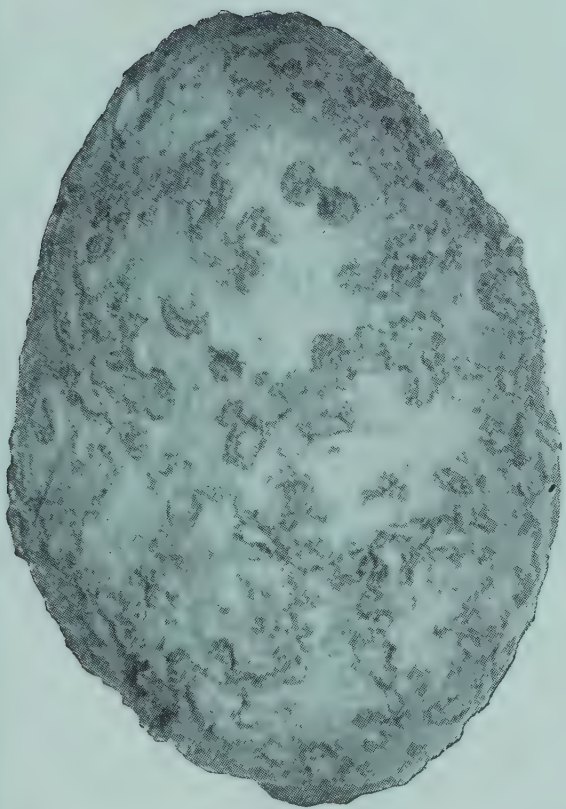
(5.) Peelings from infested potatoes, unless they have been boiled, should not be given to pigs. Burning is the safest, and in the end the most economical, method of dealing with them.

(6.) Nitrate of potash, at the rate of 2 cwt. per acre, has proved beneficial.

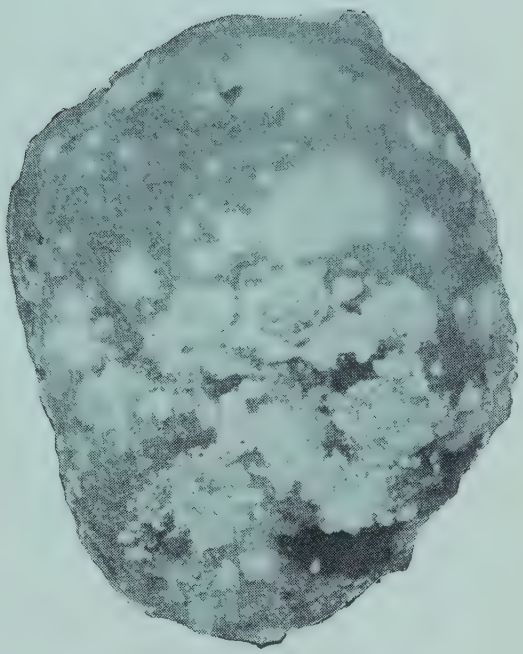
Scab due to Mechanical Injury.—This type of scab resembles the scab produced by the fungus *Oospora scabies* in the very superficial nature of the scars, which often cover the greater portion of the surface of the tuber, and are entirely due to mechanical irritation of the skin of the potato during the early stage of growth. The most general cause of irritation is the presence of ashes in the soil, and it is very prevalent in the neighbourhood of towns where night-soil is used as a manure. In an experiment conducted at Kew, for the purpose of proving the correctness of this statement, twelve potatoes free from scab of any kind were planted in soil mixed with ashes. A second row parallel with the first, planted in soil containing no ashes, acted as a control. When the crop was lifted, all the potatoes grown in the land containing ashes were badly scabbed, whereas those grown in the land not containing ashes were free from scab. This experiment has been repeated on several occasions with similar results.

In addition to ashes, certain climatic conditions favour the formation of the scab under consideration During a dry period the surface of the quickly-growing tubers presses against the comparatively unyielding soil, with the result that the skin is injured. As such injured tubers continue to increase in size, the original minute scars are stretched wider and wider, and become bounded by a somewhat raised border of wound-cork, the result being scab. This type of scab is often very prevalent or potatoes grown in sharp sandy soil during a dry season.

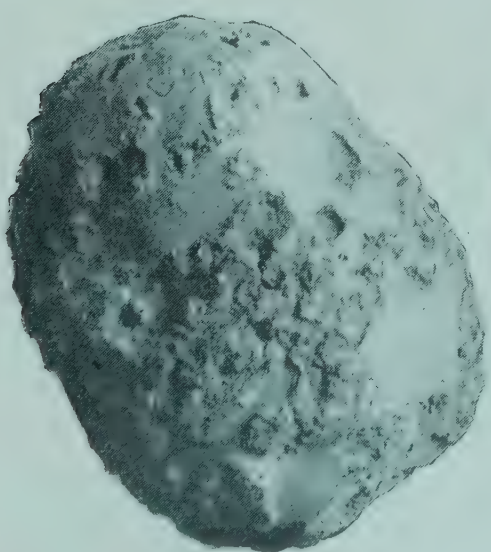
Unless complications follow, the injury caused is slight, as the wounds are only "skin deep," and such scabbed potatoes may be used for "sets." In many instances, however, mechanical injuries to the skin enable eelworms, bacteria, fungi, &c., to gain an entrance into the tuber, which may result in its complete destruction.

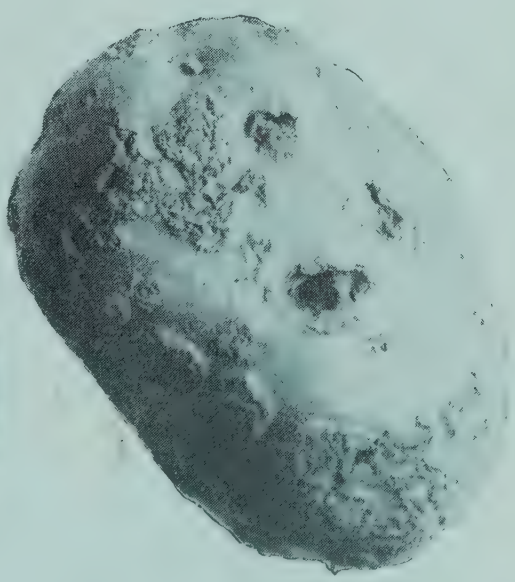


Scab Produced by Mechanical Agency.



Scab due to *Oospora scabies*, Thax.





Scab and Holes made by *Julus pulchellus*, L.

The only means of preventing this type of scab consists in an improvement in the condition of the soil.

Scab caused by Millipedes.—Among the various kinds of millipedes, popularly known as "false wire-worms," *Julus pulchellus*, L., is the greatest enemy of growing potatoes. It varies from half to three-quarters of an inch in length, and is not much thicker than an ordinary pin, pale yellowish-pink in colour, with a double row of crimson or purplish spots running its entire length. Though not generally a primary cause of injury, *Julus* readily takes advantage of any minute wound, which it quickly enlarges by feeding on the sound portion of the tuber. In some instances numerous shallow cavities are formed in the flesh of the potato, and as each wound becomes surrounded by a raised border of wound-cork, a scabbed appearance results. In other instances small holes roughly circular and of varying depth are produced, whereas in some cases, as when following on an attack of *Spongospora scabies*, Mass. (Leaflet 232), very large cavities are formed, or the tuber may be completely hollowed out. In such cavities hundreds of millipedes are often present. Millipedes are often introduced to the land in leaf mould or decaying vegetable matter. This form of scab may be reduced by destroying millipedes in the soil. (*See* Leaflet No. 94.)

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A pamphlet containing 19 leaflets dealing with Fungi injurious to Farm and Garden Crops can be obtained from the same address, price 1d., post free.

BOARD OF AGRICULTURE AND FISHERIES.

PINE WEEVILS.

Many members of the family of Weevils (*Curculionidæ*) are most harmful to vegetation, not only in the garden and field, but in the forest. In connection with forestry the most injurious species are *Pissodes notatus*, *Pissodes piniphilus*, *Pissodes pini*, and *Hylobius abietis*. Of the first three of these, *P. notatus* is the most frequent cause of complaint, whilst *H. abietis* is one of the most grievous pests in forestry.

The Banded Pine Weevil (*Pissodes notatus*).

FIG. 1.—*Pissodes notatus*. (The line on the right shows natural size.)

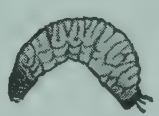

FIG. 2.—LARVA. (Magnified.)

This weevil is injurious both as beetle and as larva. The beetle in feeding pierces the bark with its rostrum or snout right into the cambium and the innermost layers of the wood; the larvæ or grubs tunnel between the wood and the bark, and the result of bad infestation is the death of the plant.

Plants Attacked.

The favourite breeding places are young pines from three or four up to eight years of age, but trees in the pole stage are also infested. The favourite host plant is Scots Pine (*Pinus sylvestris*), but in Britain the weevil has also been found in Austrian Pine (*P. austriaca*) and Weymouth Pine (*P. strobus*). It also breeds in pine cones. There are Continental records of attack on Spruce and Larch, but this is exceptional. Whilst amongst older trees the weak and sickly will be chosen for egg-laying, the thinner branches of sound trees and any part of the stem or branches of a young pine may be used.

Signs of Attack.

(*a.*) Little snout punctures, as if the bark had been pierced here and there by a needle.

(*b.*) Bead-like drops of resin issuing from these punctures.

(*c.*) Drooping of the plants, with a reddening of the needles.

(*d.*) At a late stage of the larva's work in young or smooth-barked parts, little risings on the bark may be felt by the fingers, or little ridges may be seen; these mark the position of larval tunnels or pupa beds.

Description.

The *beetle* (Fig. 1) is red-brown in colour, and measures up to $\frac{3}{8}$ in. in length; both upper and under surfaces are powdered with white scales. On the upper surface of the prothorax are four well-marked white points, and a fifth on the scutellum. The wing-covers have two transverse yellowish or whitish bands of scales, one in front and one behind their middle; the front band is non-continuous at the meeting place of the wing-covers, whereas the hind one is continuous right across the wing-covers.

The *larva* (Fig. 2) is a fleshy, somewhat wrinkled, curled, legless grub, with a brown scaly head and strong gnawing jaws.

Life-History.

The female after copulation lays her eggs in punctures made in the bark. From these hatch out grubs, which make galleries between the bark and the wood. If pines in the pole stage be chosen then several eggs may be laid near one another, and the galleries, owing to the sufficiency of room at the disposal of the grubs, show a star-like pattern; in young plants however, the larvæ tunnel downwards or upwards. A trail of brown bore-dust marks the path of the grub, which, on being fully fed, gnaws out a bed in the outer wood-layers at the end of its gallery. In this hollowed-out bed, protected by a cover of sawdust and wood chips, the pupal stage is passed. The beds (Fig. 3) may be made all down the stem of the young pine, and also for an inch or two below ground. A very favourite place is immediately below the whorl of branches, where, in an infested plant, one is almost sure to find several beds clustered together. The yellowish-white coloured pupa gradually darkens into the beetle, and this when ready to issue bores a circular hole through bed cover and bark.

The generation is typically an annual one. MacDougall has shown* that the *Pissodes* have a remarkably long life in

* Proceedings of the Royal Society of Edinburgh, Volume XXIII.

the adult stage, and that those beetles which have bred in one year may, after hibernation, proceed anew to egg-laying. In his experiments two females lived in the imago or adult stage two years, and a male for three. Adult beetles may be met with from April (March in a favourable season) onwards to the end of September, and egg-laying may take place at any time during this period.

Preventive and Remedial Measures.

1. Where the beetles have not yet got a footing a timely and a vigorous rooting out of all suppressed or sickly pines will go far to prevent injurious attack.

2. Where the beetles occur in numbers, collecting them would be a useful measure; this plan could be adopted in nurseries with good results.

3. The great means the forester has in proceeding against this pest once it has got to work is the preparation of catch-trees or decoy stems. These consist of sickly plants or trees

FIG. 3.—YOUNG PINE KILLED BY P. NOTATUS. BARK REMOVED TO EXPOSE PUPAL BEDS WITH EXIT HOLES. (Two-thirds natural size.)

left here and there in nursery or plantation; or plants may be artificially weakened and left standing, or an older tree may be cut down and allowed to lie as a place for breeding in. In consequence of the long-continued life and egg-laying, such trap plants must be arranged, and visited and renewed at intervals through the year, from March till October. Each trap might remain for two months, when young trap plants should be destroyed, or older ones barked and the exposed larvæ destroyed. Natural aids will be forthcoming from parasitic *Ichneumonidæ*.

The Large Brown Pine Weevil (*Hylobius abietis*).

This insect is in our country the cause of the dying away of young coniferous plants, acres of which may have to be re-planted because of the weevil attack. The larvæ or grubs live in the stumps and roots of felled conifers, and therefore do little actual harm; the harm is done by the adult beetles, which gnaw the bark of the stems of young plants (Fig. 6) and the younger shoots of older plants.

Plants attacked.

The plants attacked by the adult are Scots Pine, Weymouth Pine, Spruce, Larch, Japanese larch, Silver fir, and Douglas fir. It is characteristically a conifer pest, but if the coniferous crop be not pure, but mixed with broad-leaved species such as Oak, Alder, or Birch, these latter may also be attacked.

Signs of attack.

(*a.*) Pieces may be bitten away here and there all down the young plant. The damage may extend as far as the cambium layer. Very young plants may be more or less completely barked.

(*b.*) Drops of resin (Fig. 4) may be found exuding from the wounds. These drops dry into rough masses over the stem.

(*c.*) The dying off of attacked plants.

Description.

The *beetle* (Fig. 5) measures up to half an inch in length. It has a marked proboscis, with the kneed-antennæ springing from near its apex. The colour is dark brown, with yellowish or golden hairs or scales on various parts of the body, but these are specially marked on the wing-covers, where they form bands; in old beetles, the scales may have been rubbed off.

The *larvæ* (Fig. 7) are yellowish-white in colour, legless, with brown heads and biting jaws; they have a curved form, and when full grown measure up to half an inch in length.

Life-History.

The beetles choose as their favourite places for egg-laying the stumps and thicker roots (exposed or below the surface)

FIG. 4.

FIG. 6.

FIG. 5.

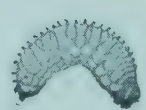

FIG. 7.

FIG. 4.—ATTACKED STEM, showing drops of resin exuding from the wounds. FIG. 5.—*H. abietis* (magnified). FIG. 6.—YOUNG DOUGLAS FIR KILLED BY WEEVIL; WITH WEEVIL FEEDING (natural size). FIG. 7.—LARVA OF *H. abietis*.

of felled pine and spruce. The eggs are laid singly, and the grubs on hatching gnaw long tunnels (Fig. 8) between the wood and the bark, these tunnels increasing in width with the growth of the grub; behind the grub the tunnels are filled with frass from the boring. When full grown the grub gnaws out a bed (Fig. 8) in the youngest wood layers, and here, under a cover of sawdust and wood chips, it may lie a long time (larvæ full grown in autumn may lie as unchanged larvæ till the next May or June) before passing into the pupal stage. The pupal stage in May or June lasts about three weeks, and the beetles issue by a round hole bored through bed cover and bark.

The adult beetles are long-lived, and Von Oppen has shown that thay can live during a season, and after hibernating can proceed anew to pairing and egg-laying. Thus in the early summer the following generations of beetles may be found at work :—(1) some of the egg-laying beetles of the previous year, which, after hibernation, continue their egg-laying ; (2) beetles which had completed their development in the previous autumn but too late to proceed to reproduction ; and, (3) beetles newly adult, which having passed the winter as larvæ or pupæ have developed into the adult during the warm weather of spring or summer.

The point of great practical importance is that there is no limited swarm period, but that beetles may be found at work feeding and reproducing during all the warm months of the year.

Preventive and Remedial Measures.

1. Removal from the felled area of stumps and roots, so as to deprive the beetles of breeding places.

2. The stumps and roots may be left to serve as places for egg-laying, but they must be grubbed up and burned, in order to destroy the enclosed brood before development has reached the adult stage.

3. Avoid having breeding places and feeding places side by side or near one another, *i.e.*, avoid cutting and planting areas in regular sequence. The longer the time elapsing between felling close to a newly-planted area the better. Much can be said for the practice of allowing stumps and roots which are left in the ground to decay before planting the area.

4. It is often recommended to make trenches, to prevent the beetles from reaching a newly-felled area for egg-laying, or to isolate a clean, newly-planted area. The trenches, a foot deep and 8 to 10 in. wide, should have steep sides and be clear of rubbish, and the beetles which fall into them must be collected every day and destoyed. Opinions differ

as to the value of such trenches. Experience shows that they may easily fail as traps, as the beetles can fly over them.

5. Branches of pine and spruce a yard long and 2 to 3 in. in diameter thrust into the soil on felling areas are used by the beetles as places for egg-laying. After some months these can be visited and barked so as to destroy the brood.

6. Experience shows that *the most efficient means of trapping* the beetles is to lay here and there on the ground in newly-cleared and infested areas pieces of fresh Scots pine bark, 8 to 12 in. long by 4 to 6 in. wide. These should be laid on the surface (not below it), with their outermost surface

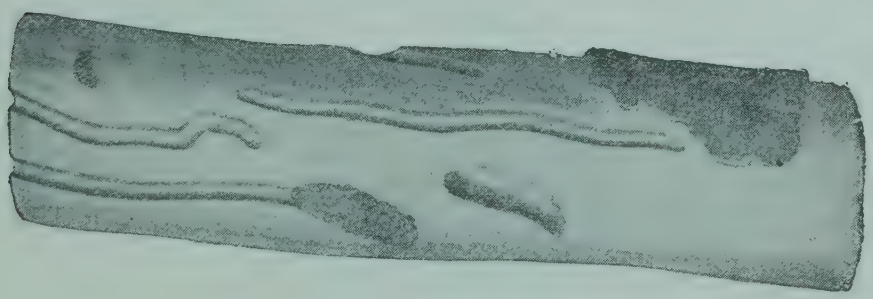

FIG. 8.—ROOT OF SPRUCE WITH BARK REMOVED, showing tunnels of grub, bed of pupa, and hole into wood made by full grown larva.

upwards. The beetles collect on the under surface for feeding. These traps must be regularly visited, and the beetles destroyed, either by dropping them into boiling water or into a vessel containing paraffin. The traps must also be often renewed, as when they dry and lose their odour they cease to attract. In Scotland, thousands of beetles have been caught by these means.

It is of the utmost importance to proceed against *Hylobius* in its breeding places, and not wait till the beetles have started to feed on the young plants.

4, Whitehall Place, London, S.W.
April, 1905.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 139.

BOARD OF AGRICULTURE AND FISHERIES.

A Mushroom Disease (*Hypomyces perniciosus*, Magn.).

DISEASED MUSHROOMS.

During certain seasons cultivated mushrooms are destroyed in a wholesale manner by this disease, not merely in this country but also on the Continent; more especially in the

neighbourhood of Paris, where mushroom culture is conducted on a very extensive scale. The primary cause of the mischief is a minute parasitic fungus, which when once introduced, spreads very quickly under the conditions of temperature and moisture essential for the rapid growth of mushrooms.

Description.

Well-marked symptoms are evident from the earliest stages of disease, the mycelium of the parasite growing up with that of the mushroom. The latter, instead of gradually developing into a cap and stem, becomes an irregularly-shaped monstrous soft mass, which if allowed to grow, often exceeds in size that of a full-grown mushroom. Sometimes a small, deformed cap is present, but as a rule the entire mass of a diseased mushroom consists of a much swollen stem. After a time the parasite forms its spores on the surface of the diseased mass, appearing under the form of a snow-white, minutely velvety covering. After the spores are scattered the diseased mushroom rapidly decays, forming a putrid mass having a very disagreeable pungent smell.

Remedial Measures.

Numerous toadstools and other fungi suffering from the parasitism of different kinds of *Hypomyces* are common in our woods and pastures every season, and spores are probably introduced into the mushroom bed along with the manure or road sweepings commonly used.

(1.) In some instances it is certain that the spawn is infected before it is placed in the mushroom bed. In such cases, when the spawn commences to "run," the threads, instead of having a clear and sharp outline like white cord, present a fluffy appearance, due to the presence of the parasite on the surface of the strands; the branches are also much fewer in number than when the spawn is healthy and growing vigorously.

Under such circumstances the entire bed should be removed before the parasite produces spores; otherwise, if the house becomes thoroughly infected, common experience has shown that the disease is exceedingly difficult to eradicate.

(2.) When infection occurs through the introduction of spores into the house by wind or other causes, the disease may be confined to certain portions of the bed, and the prompt removal of infected mushrooms as soon as the slightest symptoms are observed may check the disease from assuming the proportions of an epidemic.

(3.) After removing the soil and manure of an infected bed, great care should be taken in cleansing the tools, boots, and even clothing; otherwise there is great risk of infecting other beds. Rejected soil and manure should be at once

removed from the neighbourhood of the mushroom beds. They may be applied to the land, as the contained spores, so far as is known, can only develop on some kind of fungus, and do not attack any other cultivated crop.

(4.) When a house or other structure in which mushrooms are grown has become infected, it should be completely emptied and thoroughly sprayed, both roof, walls, and floor, three times at intervals of ten days with a solution of sulphate of copper—one pound of sulphate to fifteen gallons of water.

During this period of spraying the house should be keep warm and moist, for the purpose of favouring germination of the spores of the parasite, which are destroyed with greater certainty when growing than when in a resting condition.

4, Whitehall Place, London, S.W.,
June, 1905.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Felted Beech Coccus (*Cryptococcus fagi*).

Distribution.

This insect confines its attacks exclusively to the beech (*Fagus sylvatica*), and is one of the most destructive pests against which the arboriculturist has to contend. It is widely distributed throughout England, and has occurred in many parts of Scotland. It is common in the counties of Flint and Denbigh in North Wales; while in Ireland it has, so far, been recorded from one locality only. Its attacks are often restricted to a comparatively small area, or even to single isolated trees, this being especially noticeable where the tree-trunks are sheltered from the prevailing winds.

Signs of Infestation.

Owing to the whiteness of the felted covering with which the female protects its body, and also to its exposed position upon the trunks and main branches of the trees, the beech coccus is at all times a conspicuous species, and more especially so when the white secretionary coverings unite and almost completely cover the bark of the tree.

Young and old trees are alike attacked; and the insects usually confine themselves to the main trunk and larger branches; but the smaller branches, especially those of young trees, are sometimes infested to a serious extent: in a case recently recorded a beech hedge 13 to 14 feet high was here and there badly infested. Where the infested trees are growing in exposed situations the insects almost invariably select the sheltered side of the tree. Many badly infested trees which have been under close observation for the last sixteen years are still apparently vigorous and healthy, while others have been totally destroyed. The first sign of decay is usually seen in the foliage, which becomes discoloured and sparse or thin, accompanied by the death of the smaller branches; this is followed by the death of the larger branches and, finally, the tree trunk; while the bark peels off from the branches and falls away. Whether the work of destruction is aided by the joint action of a bacterial or fungoid disease is not at present known, but it is probable that such is the case.

Description and Life-History.

The beech coccus belongs to the generally destructive family of Scale insects (COCCIDÆ). *The adult female* is of a lemon-yellow colour, and measures about one twenty-fifth of an inch in length. It is both wingless and legless; is somewhat hemispherical in shape, being

flattish beneath and highly convex above ; and to the naked eye or under low magnifying power it appears like a small yellow egg. The mouth organs are placed on the underside of the body, and are composed chiefly of three hair-like appendages which in life are united to form a long sucking tube ; with this slender apparatus the insect pierces the bark and sucks up the juices of the tree. She has no power of locomotion, remaining stationary throughout life, anchored to the tree by her mouth organs, motionless and apparently senseless. Almost immediately after leaving the egg she covers her body with the white felted secretion, composed of fine filaments of wax, which gradually thickens and forms an excellent protection to her body, being practically impervious to rain. Within this covering the insect lives, lays her eggs, and dies.

The *larvæ* or "lice" as they are sometimes called, are very tiny active creatures, and are scarcely visible to the naked eye. They possess three pairs of legs and a pair of horns (antennæ), and, like their parents, are of a yellow colour. Although they can and do travel over the bark of the tree, they usually settle down in the immediate neighbourhood of the parent, the majority working their way under the bodies of their dying or dead parents, taking up their positions, by preference, in the deepest parts of the fissures in the bark, where they remain for the rest of their lives pumping up the juices of the tree. Each individual protects its body with secretion, which adds to that already secreted above them by the insects of the previous generations ; thus the secretion gradually thickens and spreads over the tree-trunk, forming a more or less continuous mass, often attaining a considerable thickness. Larvæ which wander over the bark are liable to be borne away by the wind or, inadvertently, by birds and insects, and this is undoubtedly the means by which fresh colonies are started.

The *male* is unknown in any stage, the females being parthenogenetic, reproducing their species without the intervention of the opposite sex.

Many of our indigenous Scale insects are subject to the attacks of minute parasitic insects related to the wasp family ; but, so far, the beech coccus has proved immune from their attacks. Birds do not appear to feed upon them.

Treatment.

Owing to the comparatively smooth nature of the bark of the beech, and also to the fact that the insects are often confined to the trunk and main branches, this pest is more easily accessible for treatment with insecticides than are many other pests. They are, however, so well protected by their waxy coverings that the application of an insecticide must be carried out in a thorough manner or the result will be anything but satisfactory.

FIG. 1.

FIG. 2.

FIG. 3.

Fig. 1.—Main trunk of young beech badly infected with coccus. Fig. 2.—Young beech, which was similarly infected to that shown in Fig. 1, 21 months after treatment with paraffin emulsion; now free from the pest. Fig. 3.—Upper branches of very old beech killed by the coccus; the bark has peeled off in patches.

1.—The trees should be sprayed, when in the dormant condition, with the following emulsion-soda wash, as used at the Woburn Fruit Farm:—Paraffin, 2 gallons; soft-soap, 1½ lb.; caustic soda (98 per cent.), 6 lb.; water, 28 gallons.

In order to prepare the wash the soft soap should be dissolved in a gallon of boiling water; the paraffin should then be added and the mixture churned thoroughly until a cream-like mass results. The thoroughness of the churning is important.

The 6 lb. of caustic soda should next be dissolved in the remaining 27 gallons of water and then poured into the paraffin emulsion. The whole should be well mixed and used immediately.

Recent experimental work at Woburn, however, indicates that there are advantages in using a wash composed of:—Sulphate of iron, ½ lb.; lime, ¼ lb.; paraffin (solar distillate), 5 pints; caustic soda (98 per cent.), 2 lb.; and water to make 10 gallons.

This may be prepared for use by proceeding as follows:—(*a*) Dissolve the sulphate of iron in about 9 gallons of water; (*b*) slake the lime in a little water, and then add a little more water to make it into a "milk"; (*c*) run *b* into *a* through a piece of coarse sacking to remove grit; (*d*) pour the paraffin into the mixture *c* and churn the whole thoroughly; (*e*) add the caustic soda in powdered form just before using, and stir thoroughly.

In using either of these mixtures the face and hands must be protected, as the mixtures are caustic in character.

One advantage of the caustic soda is that it helps to clear the tree of such growths as lichens and algae.

2.—On a trunk which is clean save for the Felted Beech Coccus paraffin emulsion would prove satisfactory.

Even with the most careful spraying there would be crevices and protected places in the bark that would almost certainly not be reached, and for such places a good scrubbing brush with stiff bristles—wire bristles are good—should be used. The brush should be dipped in the wash and the spots referred to scrubbed.

In dealing with an isolated infested tree, or with a few trees only, brushing would be more effective than spraying, and once the treated trees are clean they should be kept under observation, so that any places showing new or increased infestation could be brushed over.

4, Whitehall Place, London, S.W.
May, 1905.
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BOARD OF AGRICULTURE AND FISHERIES.

The Preparation of Honey for Market.

Qualities of Good Honey.

The bee and honey classes of the shows now held during each season, both in London and the country, have taught the consumer what to require in a first-class honey, but it remains none the less true that it is often difficult to obtain remunerative prices for honey. Before bee-keeping is embarked in on a large scale, therefore, arrangements for marketing the produce should be made. Comb-honey (in section cases) should be translucent, showing the clear bright colour of the contained honey, evenly and delicately worked out to the sides and bottom of the section, and with a scrupulously clean surface. The finest liquid extracted-honey should be bright and clear, of a light straw colour, and delicate in flavour and aroma. Granulated extracted-honey should be of fine, even grain, creamy white in colour, and of good flavour. There are many grades of medium and dark-coloured honeys below this first-class standard, but the latter is what the bee-keeper must strive to attain, in order to command a ready sale for his produce.

Preparation for Comb-Honey in Sections.

In regard to comb-honey, the preparation commences with the fitting of the wax foundation in the sections. To ensure a well worked out section this should be cut so as just to clear the sides of the wood and hang to within one-sixteenth of an inch of the bottom, thus allowing for a slight stretching of the foundation caused by the heat of the bees clustering on its surface. The fitted sections must next be placed in the section rack, with separators between the rows, reaching to within three-eighths of an inch of the top and bottom, and wedged up perfectly square and tight; this is important, for the bees will place *propolis* over every crack or small space, causing disfigurement and extra work in cleaning; also sections "out of square" are much more liable to breakage when packed for travelling, owing to the unavoidable spaces between them. The rack must be placed perfectly level on a hive containing a strong colony of bees; it will then be filled with good, straight, and even combs.

Removing filled Racks.

Removing filled racks from the hives should be done with as little disturbance to the bees as possible; the best method is to (1) place a "super-clearer" on a stool or box by

the side of the hive, raise up the bottom edge of the rack and insert a small wedge; (2) puff a little smoke between the rack and tops of the frames, remove the rack steadily with a screwing motion, and put it down gently on the "super-clearer"; (3) place a cloth, on which a few drops of carbolic acid have been sprinkled, over the top of the frames; (4) in about ten seconds remove the cloth, and it will be found that the bees have been driven down, leaving the tops clear; (5) then immediately take up the rack with the "super-clearer" and place it on the frames. If this operation is carried out in the afternoon, by next morning every bee will have found its way down to the body of the hive through the bee-escape in the centre of the "super-clearer," and the rack can be removed with comfort to the bee-keeper and without disturbance to the apiary.

The full racks should be carried into a bee-proof room, the wedges and back-board removed, and the centre section of the exposed row taken out. It should not be lifted straight out, as the result would probably be a damaged section, but if tilted backward on its bottom edge, it will loosen and come away easily, as also will the two side ones. The sections should be sorted as they are taken out, placing all well-filled clear ones in the first grade; those not well-worked to bottom and sides, and therefore not fit for travelling, will make a second grade; and any only partially filled must be given back to the bees to finish, unless the "honey-flow" has ceased, in which case they must be emptied by the extractor (*see* p. 3). All propolis must be carefully scraped from the edges of the sections, which, if not already sold, should be stored in a dry, warm cupboard, and protected from dust by tying them in packages of four or six in clean paper; care must be taken not to place anything having a strong odour near the honeycomb, or it will spoil the flavour of the honey.

Packing Sections.

If the sections are sold to wholesale dealers for re-sale to traders, no further preparation is needed. To pack them so as to travel safely, not more than from four to six dozen, preferably the smaller quantity, should be put into one package.

Packing may usefully be done as follows:—(1) Procure a strong wooden box, bore two holes in each end, about one-third down, and knot firmly into them rope handles, by which the box can be safely and easily lifted; (2) in the bottom of the box put a bed of straw, and on this place, quite close together, a layer of the wrapped-up packages of sections, leaving at least two inches between the sides of the box and the sections: this space must be filled with straw, tightly pressed in, and, to prevent possible damage to the comb, the ends of the packages may be protected by pieces

of straw-board or thin wood; (3) continue with layers of packages, filling in round the sides as before until within two inches of the top; (4) then fill up tightly with straw, and *screw* on the lid. Packages should be plainly labelled: "Comb-honey, With Care." Retailers of honey-comb prefer to have the sections sent to them glazed, the comb being thus preserved from injury by careless handling, and, what is still more important, kept free from the dusty impurities unavoidably present in shops.

Glazing the Sections.

For glazing sections, glass cut to the correct size may be purchased of any dealer in bee appliances, together with the strips of paper lace edging, which, when pasted round the angle formed by the glass and wood, serve to fix the glass on. In country towns the local glazier will gladly cut up waste glass to the small size (viz., $4\frac{3}{16}$ in. by $4\frac{3}{16}$ in.) required, while neatly printed bands of coloured paper, 19 in. by 3 in., can be used instead of the lace edging. These bands cost about 7s. per 1,000. They are more easily pasted on than the paper lace edging, and make much firmer and neater work, while they also give an opportunity of placing the names of the apiary and retailer on each section. Neat card-board cases, plain or glazed on one or both sides, can be purchased cheaply from appliance manufacturers.

"*Extracting*" *Honey.*

"Extracted" or "run" honey has been greatly improved in quality by the modern method of obtaining it; and the use of the centrifugal extractor compels the abandonment of the skep system of bee-keeping, with its waste of bee life, waste of combs, and taint of sulphur. This method also necessitates the adoption of the frame hive, which enables the gathered surplus to be stored in frames apart from the brood-nest and to be removed at will by the bee-keeper.

Honey improves in flavour and density while ripening in the hive, therefore the shallow frames should not be removed until the honey is well sealed over. The full sealed frames of comb having been carried into the store-room, they should be sorted by holding them up to the light, and all those containing dark or second quality honey may thus be separated from the better ones. Fermentation is the great enemy of extracted honey, but it can only affect badly ripened honey or honey exposed to moisture and warmth; if therefore it should be necessary to extract unripe honey, it should be returned to the bees for re-storing and ripening.

Extraction is done by means of a machine consisting of a tinned-iron can, within which is a vertical spindle carrying a pair of cages to hold the frames of honey-comb and made to revolve rapidly by means of a simple hand-gear. Before placing the frames of comb in the cages they must be uncapped. To do this quickly and without waste

special uncapping knives are used ; they should be heated in a tin of water kept hot over a small spirit or oil lamp. The full frame, held by one lug in the left hand, the other lug resting on a large dish and with the top edge overhanging, has its capping removed with the sharp, hot knife by a gentle, slightly sawing, downward cut, passing just beneath the surface and removing as little as possible of the honey. If held with sufficient overhang the detached sheet of capping will fall clear of the frame. A pair of frames having been uncapped they are placed in the cages of the extractor and made to revolve rapidly with their bottom bars leading ; the centrifugal force throws out the honey, and when one side has been emptied the frames are reversed and the other side treated in the same manner.

Packing Extracted Honey.

After uncapping and extracting the contents of the best combs, the honey should be strained through a bag made of muslin in order to remove all loose particles of wax. Tin cans, with strainer and honey tap, made to contain 56 lb. or 112 lb., can be obtained, in which, if the honey is allowed to stand for twenty-four hours after straining, it will be freed from air bubbles, and can then be drawn into whatever jar, or tin will best suit the local market. Best honey is usually put into 1 lb. or ½ lb. glass jars, with metal screw caps having a cork wad inside the cap. To prevent any leakage the cork wad should be dipped in melted wax and placed on the jar while still warm, the cap being screwed down upon it. A neat label (of which varieties are obtainable from appliance makers or from the Secretaries of many of the County Bee-keepers' Associations) will set off the honey jar and make it more attractive. The darker honey is more suitable for marketing in its granulated state ; when extracted and strained it should be run into 14 lb. or 28 lb. tins, the contents of these being stirred gently, now and again, while granulating ; the stirring tends to produce a more even and finer grained honey. It may also be run into wide-mouthed glass or earthenware jars, covered down with parchment paper, and stored in a cool, dry place. Dark and coarse-flavoured varieties may be sold for manufacturing and confectionery purposes, or for that now almost forgotten process the making of mead.

4, Whitehall Place, London, S.W.,
May, 1905.
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BOARD OF AGRICULTURE AND FISHERIES.

Calf-Rearing.

From the calf's standpoint it may at once be conceded that there is no method of rearing a calf equal to the natural one of allowing it to run with its dam. But at the present time, when the production of milk for sale is recognised as one of the most profitable sides of British farming, this simple plan of calf-rearing, at least with the dairy breeds of cows, will not pay. With the poorer milking breeds of cattle, such as the Herefords, Galloways, Highlanders, &c., calves are still frequently allowed to run with the cows, but in such cases the farms are mostly or entirely in grass and hardly adapted for winter dairying, while the calving occurs in late spring or early summer when grass is available, and the cows are cheaply kept. Still, when it is considered that as a rule a calf requires six quarts of new milk a day, the wholesale value of which is ninepence, while the market value of good stores of a year old allows approximately for only half this daily outlay (say, first value, £1 10*s.*, and 365 times 4½*d.* = £6 16*s.* 10½*d.*; total, £8 6*s.* 10½*d.*), it will be seen that new milk continued for long is far too expensive a calf-food.* In fact, at the rate of ninepence a day a calf is costing more to keep than a heifer near to her time of calving. Moreover, calves can be well reared as stores, and even well fed for veal with but a small consumption of new milk. In the case of pedigree calves, more especially the bulls, the higher anticipated sale prices generally justify the use of new milk up to even the age of twelve months; but good, well-grown bulls can be reared without much new milk.

A method which has been followed for some years with considerable success on a north-country farm, where a herd of good milking Shorthorns is kept, and both butter and cheese are made, is described in the following pages.

The Calf-House.

This is a spacious "lean-to" building on the south side of a higher one, and is lighted by means of single panes of glass at regular intervals in the roof. The floor is of concrete,

* The prices mentioned throughout this leaflet are of course subject to fluctuation, and at any given time will vary somewhat according to locality.

with no drains either open or covered. The two doors, each in halves, are on the same side, so that there may not be cross-draughts. The pens (6 ft. by 5 ft.) are on each side of a central gangway with board partitions not quite down to the floor, and palings in front, so that the calves may see each other across the gangway. Each pen contains a small trough and hay-rack.

Before a new-born calf is placed in its pen the floor is littered with about an inch of well-broken moss-litter, and this is covered with a fair bedding of straw. A little extra straw is added day by day as required, and at the end of a week the pen is cleaned out. Afterwards moss-litter only is used, a bucketful being scattered on the top as frequently as appears to be necessary, the pens being cleaned out about once in three weeks. Moss-litter is such a good absorbent and perfect deodorant that no offensive odour is noticeable and no drains are required. When removed from the calf-pens it is still too dry to place on the manure heap, but it forms an excellent substance to place round the heap to absorb the liquid drainings ; when saturated it is thrown on the top.

It will thus be seen that provision is made for comfortable and dry beds, sunlight, and fresh air, while an incentive is given to exercise on the part of the calves by the sense of companionship which they feel in seeing one another. These are conditions not difficult of attainment which might well be aimed at in the construction of every calf-house.

The New-Born Calf.

The calf, as soon as it is "dropped," is removed to its pen, and neither calf nor dam appears seriously to notice the separation. The hollow of the hand of the attendant is filled with carbolic oil (1 part Calvert's No. 4 carbolic acid to 19 of Galipoli oil), and this is applied freely to the calf's navel to prevent the absorption of microbes.

The calf is now rubbed down with a wisp of straw and allowed to lie covered over with straw till its mother has been milked. In the natural way, the calf would not suck the cow until it got well on its feet, and there need be no hurry, for half an hour or so, to give it its first meal when separated from the cow in mild or warm weather ; but in cold weather it is considered important that it should have a drink of warm milk as soon as possible. In all cases milk is given to the young calves at the blood-heat of the cow (101 deg. to 102 deg. F.) which is the temperature at which a calf would get it from the cow by sucking. Now by the time the milk has streamed through the cold air into the cold milk-pail it will be at least 10 deg. below this, and it is therefore heated, either by the addition of a little hot water or otherwise. It may

be well here to give a special caution against serving milk too hot either at this stage or later; it is better to err on the side of not having it warm enough than of having it really hot.

Feeding the Calf.

The two forefingers are placed in the calf's mouth, and the hand is lowered into a bowl of the colostrum (first milk), and, usually, the calf at once sucks vigorously, but sometimes a little patience is required before it discovers its ability to suck. A quart is sufficient for the first meal, and most calves readily take this amount, and many would take more if allowed. Colostrum or "biestings" differs in many respects from ordinary milk, for it contains about five times as much albuminoid (lean, hair, and other tissue-forming) matter, and nearly twice as much mineral (bone-forming, &c.) matter. Further, the albuminoid matter instead of being mainly in the form of curd (casein), as in milk, is chiefly in the form of albumen (white of egg), which will not curdle in the calf's stomach, and practically needs no digesting; it, however, coagulates with heat, so that in warming "biestings," care should be taken not to allow it to get really hot. The old-fashioned custom of giving a new-born calf an egg is, therefore, unnecessary, for albumen is abundant in the colostrum already. In the course of about five days colostrum gradually assumes the character of ordinary milk, and it sometimes happens that a newly-calved cow is sold a day or two after calving, or a calf a day or two old is purchased, or a cow dies from bleeding at calving, and no colostrum is available for the calf; in such a case a useful substitute for the first three days is made by whipping up an egg with half a pint of warm water, adding half a teaspoonful of castor oil, and stirring in one pint of new milk, for each meal.

Dietary.

The calf is given three meals of milk a day, viz., at 6.30 a.m., 12.30 p.m., and 5.30., p.m., until it is eight weeks old, that is, until it eats hay freely, and will go to its hay-rack when hungry. It is most unnatural for infant animals to go long without food during the day, and the daily allowance of milk given at two meals instead of three is often the cause of trouble with calves.

On the third day the use of the fingers is discontinued, and the calf is made to drink from a small pail, and by this time it takes greedily two quarts at each meal. At the end of a fortnight half the new milk is discontinued, and the meal now consists of one quart of new milk and three pints of separated milk, with a cream substitute. Three such substitutes have been used with most satisfactory results, viz.:—

(1) *Boiled Linseed.*—Two pounds of linseed are put to soak over night in three gallons of water, boiled and stirred the next day for twenty minutes, and five minutes before the boiling is finished ½ lb. of flour (previously mixed with enough water to prevent it being lumpy) is added to this gruel to counteract the laxative tendency of the linseed. This will keep sweet for many days, and is, therefore, made in considerable quantity; one pint of this gruel is added to four pints of separated milk.

(2) *Ground Linseed.*—Unground linseed is obtained to ensure having the whole of the oil, and is ground by ordinary millstones. (It is found necessary to add one part of Indian meal to seven of the linseed to prevent it clogging the mill.) This meal is scalded and stirred with boiling water at the rate of one quart of the meal to one gallon of water. This makes a porridge of much nicer consistency than the boiled linseed, and is more quickly and easily prepared; one pint of this porridge is used to four pints of separated milk. Linseed cake meal is frequently employed for making a calf porridge to add to skimmed or separated milk, but, although a wholesome food, it does not enrich the milk with fat as linseed itself does, for linseed cake would not contain more than 12 per cent. of oil, whereas linseed contains 32 per cent.

(3) *Cod-Liver Oil.*—The genuine article is found to answer admirably, and gives practically no trouble; and when it can be bought at 4*s.* 6*d.* per gallon it is a cheap cream substitute. A tablespoonful is measured into a calf bucket, and the warm separated milk for one meal poured on to it, and the mixture poured into another bucket to well mix or emulsify the oil, and it is at once served to the calf. A calf thus gets three tablespoonfuls a day, or half this quantity during the second fortnight, while having part new and part separated milk.

All things considered the use of (2)—the scalded ground linseed—seems preferable, and at 1*s.* 9*d.* a stone will scarcely cost 3*d.* a week, or 1*s.* 6*d.* altogether for each calf.

New milk is discontinued at the end of the first month, and for the next month the allowance of separated milk for each of three meals is three quarts with cream substitute. If the calf is intended for veal an extra pint of milk is given, and the fattening is hastened by a further addition of boiled flour or oatmeal to the milk, or even a good dessert-spoonful of sugar. Calves not intended for veal are given sweet meadow hay in the fifth week, at which age they begin to chew the cud. At the ninth week the mid-day milk is replaced by a handful of linseed cake (6 oz.), and the calves get a good drink (five quarts) of separated milk morning and evening without cream substitute. As they get older the hay and linseed cake are gradually increased until in the fifth month the calves get half a pound of linseed cake a day and eat about 5 lb. of hay. A little crushed oats (¼ lb.) is now added to

the cake, and sliced swedes are given. At six months old milk may be discontinued altogether, but this comes about gradually, the evening's milk being first stopped; in fact, all food-changes with calves should be gradual.

Calves born before March are turned out to grass as soon as the weather is mild (June probably), but do not lie out at night until hoar frosts are well at an end, and they continue to receive their daily allowance of linseed cake and meal. Calves born in the spring and summer months are not turned out that year, experience having shown that these calves thrive much better off the grass, escape that very troublesome calf disease—hoose, and turn out better stores the following spring. Indoor calves begin to receive green-meat, such as cut grass or vetches, in the summer, and sliced swedes in the winter, when five months old. Their feeding during the second half of the first year simply consists in foddering with hay and serving with cut swedes morning and evening in steadily increasing quantities, giving cake and meal at mid-day up to 1 lb. of cake and ½ lb. of meal per head at the age of from nine to twelve months, and letting out to water and exercise at 10 a.m. A lump of rock-salt lies at each end of their trough for them to lick. Regularity of feeding is a matter of prime importance in the management of all kinds of cattle.

The calf dietary for the first six months as above described may be shortly tabulated as follows :—

First Week.—Its own mother's warm milk three times a day, commencing with about a quart and increasing to two quarts by the third day.

Second Week.—Two quarts of warm new milk (not necessarily its own mother's) three times a day.

Third week.—Two pints of new and three pints of skim (or separated) milk, three times a day, with half a pint of linseed porridge or half a tablespoonful of cod-liver oil.

Fifth week.—Three quarts of warm skim milk three times a day, with one pint of linseed porridge or one tablespoonful of cod-liver oil, and a little sweet meadow hay, increased week by week.

Ninth week.—Mid-day milk and cream substitute omitted. Five quarts of separated milk are given morning and evening, a handful of broken linseed cake (6 oz.) at mid-day, and hay, increasing week by week.

Thirteenth week.—Milk as before, ¾ lb. mixed linseed cake and crushed oats, ½ gallon pulped swedes (green-meat in summer), gradually increasing, hay *ad lib.*

Twenty-first week.—Milk as before, 1 lb. of mixed linseed cake and meal, increasing quantities of roots, hay *ad lib.*

Twenty-fourth week.—Evening milk is discontinued.

Twenty-seventh week.—Milk altogether discontinued.

Although skim-milk is somewhat richer in fat than separated milk, yet the latter has an advantage over the former in being perfectly fresh and sweet when given to the calves, and if served to them morning and evening shortly after being separated, needs no warming. It will pour into the calf pail clear of the froth if allowed to stand for a short time, or the froth may be held back with the hand.

Cost of Rearing.

The cost of rearing a calf for a year under this system is as follows :—

		£	*s.*	*d.*
For first 12 weeks.—120 quarts new milk at 1½*d.* ...	=	0	15	0
Linseed meal	=	0	1	6
150 gallons separated milk at 1*d.*	=	0	12	6
6 stones of hay at 4½*d.* ...	=	0	2	3
12 lb. American linseed cake at £7 15*s.* a ton	=	0	0	10
For next 14 weeks.—220 gallons separated milk at 1*d.*	=	0	18	4
49 lb. American linseed cake at £7 15*s.* a ton	=	0	3	5
32 lb. crushed oats at 8*d.* a stone	=	0	1	6
10 stones swedes at ½*d.*	=	0	0	5
30 stones of hay at 4½*d.* ...	=	0	11	3
For remaining 26 weeks—182 lb. linseed cake at £7 15*s.* a ton	=	0	12	7
91 lb. crushed oats at 8*d.* a stone	=	0	4	4
91 stones of hay at 4½*d.* ...	=	1	14	1
70 stones of swedes at ½*d.* ...	=	0	2	11
		£6	0	11

Bullock calves thus reared easily sell at a year old at the local spring sales of store cattle at £8 5*s.* each, thus paying the *market* price (less the cost of marketing) for home-grown produce eaten, 6*d.* a gallon for the new milk, and 1*d.* a gallon for the separated milk consumed, leaving £2 4*s.* for the first value of the calf and a small margin for risk. The manure produced is taken as a set-off against the value of attendance and litter. In the case of well-bred heifer calves intended for breeding the value at a year old would be considerably above this store price.

In rearing young bulls the linseed porridge with the separated milk is continued for, say, six weeks longer than with other calves, and the separated milk is given alone to the end of the eighth month, at the same time doubling the quantities of linseed cake and meal. This involves an extra expenditure of 35*s.*, while if the calf has been well selected at the commencement he easily realises £5 or £6 more at a year old than an ordinary store bullock of the same age.

Milk Substitutes.

On milk-selling and cheese-making farms separated milk is not available, and without it calf-rearing becomes a difficulty ; not that it is difficult to devise from a table of food-stuffs a calf meal that shall closely resemble milk in its digestible constituents, but this cannot be done without at the same time introducing a much larger amount of indigestible matter than occurs in milk. The consequence

is that, usually, calves reared on calf meals alone are "pot-bellied" badly-grown animals, instead of having the well-grown, level-fleshed, and alert appearance of milk-fed ones.

This question of indigestible matter, and that of choosing meals that will agree with the calf, constitute the practical difficulties; and yet probably most milk-sellers and cheese-makers would be glad to rear the heifer calves from their best milking cows if there were a fair prospect of doing so successfully with very little milk. The following meals have, on the farm mentioned, proved to be good milk substitutes, and, used as directed, provide an albuminoid ratio about the same as that in new milk—

CALF MEAL No. 1.—Used when a small quantity of separated milk is available :—

8 parts of oatmeal (by weight).
1 part of ground linseed.

Scald 2¼ lb. over night with five pints of boiling water, boil for ten minutes next morning, and add five pints of separated milk with about ¼ oz. of salt and 2 oz. of sugar.

No. 2.—When no separated milk is available :—

2 parts linseed cake meal.
2 parts oatmeal.
1 part ground linseed.

Mix 3 lb. with five quarts of boiling water over night, and boil for ten minutes next morning; serve with salt and sugar as with No. 1.

No. 3.—Requiring no boiling :—

14 parts linseed cake meal.
5 parts ground linseed.
2 parts wheat flour.
2 parts locust bean meal.

Mix 3 lb. with five quarts of boiling water and a sprinkle of salt.

Where No. 2 or No. 3 is used it is introduced and the new milk reduced very gradually thus :—

First Week.—Mother's milk only.

Second and Third Weeks.—Three pints of new milk and one pint of the gruel at each of three meals.

Fourth and Fifth Weeks.—Two pints of new milk and two pints of gruel.

Sixth and Seventh Weeks.—One pint of new milk and three pints of gruel.

Eighth Week.—Two quarts of gruel and no new milk.

Hay is introduced, as with other calves, at the fifth week.

*Loss of Calves.**

Loss among calves is often attributed to the use of cotton cake with the cows, but at this farm the cows when housed get in the regular way 4 lb. of decorticated cake each per

* For information as to White Scour in calves *see* Leaflet No. 101 (*Prevention of White Scour in Calves*).

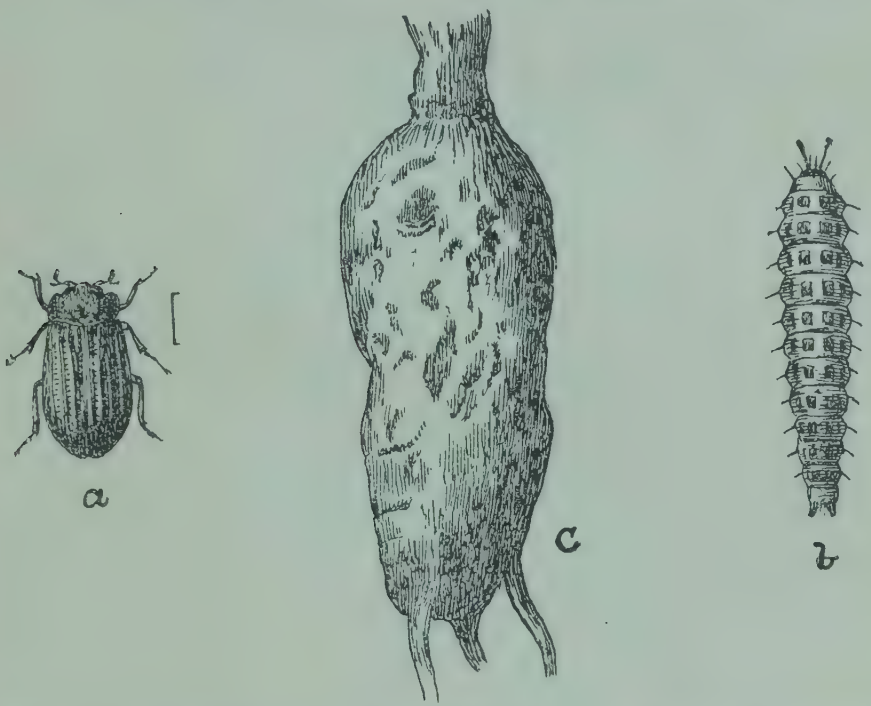
day, and for the latter half of the summer 2 lb., and yet, with the exception of one calf that died from eating moss-litter, one from inflammation of the lungs, and three others, there have been no losses in nine years out of a total of 180 calves born. It should, however, be stated that when a cow's milk falls to five quarts a day, cake is entirely discontinued, as she does not pay for it and can be kept in good condition without it. Practically, therefore, no cow gets cotton cake for at least two months previous to calving ; nor does she get cake in the week following calving. After the first week of its life, however, a calf is fed with the milk of any cow, or with the milk of several, even if receiving the usual allowance of cotton cake.

4, Whitehall Place, London, S.W.,
May, 1905.
Revised, November, 1906.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Turnip Mud-Beetle (*Helophorus rugosus*).



HELOPHORUS RUGOSUS.—*a*. Beetle, magnified. *b*. Larva, magnified (after Ormerod). *c*. Turnip, showing gnawings of grub.

The Turnip Mud-Beetle (*Helophorus rugosus*) belongs to a family of beetles the life histories and food habits of many of which are imperfectly known. The best known members of the family are aquatic, both as adults and as grubs, and the grubs may be vegetable feeders or they may be carnivorous. The species of the genus *Helophorus* are non-swimmers, although they can be found on water, near water, and in mud. They are capable of flight, and species have been found away from water on herbage.

Distribution.—As to the distribution of *Helophorus rugosus*, Fowler describes it as "rather local, but widely distributed through England and Wales inland and near the coast, not so common in the north; Scotland, scarce: Lowlands, Tweed, Forth, Solway, and Dee districts." It is interesting to note that, so far as is known, all the complaints made as to the destructive work of this beetle have come from Aberdeenshire.

Method of Attack.—(1.) The leaves may be eaten. (2.) The leafstalks may be holed and tunnelled. (3.) The swollen root-tubers may be irregularly gnawed and tunnelled on the outer surface, especially in the upper part.

The harm is done by both beetle and grub. A favourite place for the pests is at the crown of the tuber sheltered amongst the leaf bases, the young leaves being destroyed as they come forward. Attacked leaves curl up, and attention may be drawn to the presence of the pest by the curled leaves standing straight up from the tuber and close together. The holes made in the tuber afford entry to rain and fungous enemies, and the plants may die off.

Description.

Beetle.—The adult insect measures about one quarter of an inch in length; it is oval, oblong, and somewhat broad. The colour is dark reddish, but the redness may be obscured by a covering of mud. The thorax is irregularly ridged and knotted, with its front angles prominent. The wing-covers show here and there dark markings; between the longitudinal ridges of the wing-covers are rows of punctures. The legs are pale red, and the antennæ of the beetle are somewhat thickened towards the top.

Grub.—The appearance of the magnified grub is well shown in the illustration. The dark coloured head has brownish jaws. The three segments behind the head each carry a pair of legs; on the upper surface of these thoracic segments is a dark transverse curved line, whilst down the back of the remaining segments there are two rows of large square spots, with rows of smaller spots below down each side. The body ends in two processes. Some grubs sent to the Board of Agriculture and Fisheries early in October, 1904, were over one quarter of an inch in length, and were not full-fed.

Remedial Measures.

The complete life history of this beetle is not yet known, but in the observations made up to the present it has been found that turnips grown in a field adjoining a field infected in the previous year are those most likely to be attacked. For this reason, it is strongly recommended that, as far as is practicable in the rotation, turnips should be sown at a distance from the infected field. In fighting the pest the most successful measure has been the application to the crop of stimulating dressings; 1 cwt. of nitrate of soda per acre proved satisfactory on that portion of the field least infected.

4, Whitehall Place, London, S.W.
June, 1905.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Heart Rot of Beet, Mangold and Swede
(*Sphaerella tabifica*, Prill. et Del.).

Yellow Globe Mangold, showing Heart Rot.

This disease is not uncommon in France, where it often causes considerable damage to sugar beet. In this country it has of late years been frequently reported on the mangold and swede. An instance recently occurred where nearly every root grown on a four-acre plot of "Yellow Globe" mangold was badly diseased. At the time of its discovery workmen were busily engaged in cutting off the sound

portions for cattle food, and chopping up the diseased parts and scattering them over the land to be ploughed in.

Description and Appearance of Plants Infested.

The disease rarely appears before the middle of August, and first attacks the stalks of the largest leaves. Its presence is indicated by the wilting of the leaves, such as follows a hot, dry day ; diseased leaves, however, do not recover their erect position during the night, but remain lying on the ground, turn yellow, and decay. This is due to the fungus growing in the leaf-stalk having choked the vessels and thus prevented the passage of water into the leaf. When the leaf is dying, whitish patches of variable form and size, bounded by a dark line, and studded with minute black spots, the fruit of the fungus, appear on the leaf-stalk. Similar patches are also sometimes present on the leaves. Later in the season, when the leaf-stalks are dead and dry, a second form of fungus-fruit appears on the bleached patches.

Some time after the leaves have been infected the mycelium of the fungus passes into the crown of the root and thence gradually extends downwards, its progress being clearly indicated by a darkening of the tissues. The entire root is finally reduced to a blackish, decayed mass.

Preventive and Remedial Measures.

(1).—If a portion of a diseased root, which is crowded with the mycelium of the fungus, is kept until the following season, it undergoes no change until about midsummer, when its surface becomes covered with the fruit of the fungus. Such fruit furnishes the spores that infect a crop in the first instance.

When diseased roots are left on the land the same thing happens. If the disease appears, as indicated by the symptoms described, it is best to lift the crop at once before the fungus passes from the leaves to the root.

(2).—Diseased leaves and roots should be gathered and burned, or deeply buried, and should not be thrown on the manure heap or left on the land.

(3).—Yellow varieties of mangold are more susceptible to the disease than red ones, as proved by infection experiments. Red varieties might, therefore, be grown where the disease has already occurred.

4, Whitehall Place, London, S.W.,
April, 1906.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 20 leaflets dealing with Fungi injurious to Farm and Garden Crops may be obtained from the same address, price 1d., post free.

BOARD OF AGRICULTURE AND FISHERIES.

Sheep Dipping.

Sheep scab and the effects of dipping on the parasite causing this disease are dealt with in Leaflet No. 61. Dipping, however, is recommended for the destruction of certain other parasites, such as Keds and Lice.

The Ked (*Melophagus ovinus*).—This pest, often wrongly called "the tick" is probably the most widely distributed of the parasites which attack sheep. It is a member of the same order (*Diptera*) as the house fly, but is wingless. It is about $\frac{1}{4}$ inch in length, has a compressed leathery body, brown-grey in colour, and covered with short hairs. The Ked does not lay eggs; these are hatched in the body of the parent insect and the maggot is nourished there. When the maggot is deposited development is so far advanced that it at once becomes a pupa under cover of the puparium. The brown pupal cases (*puparia*) may be found at the base of the wool fibres. Reproduction is slow, each female producing about three to five pupæ at intervals of a few days, after which it dies. Keds are for the most part spread by contact of one sheep with another. The mature creatures cause great irritation and loss of condition.

The Sheep Tick.—Ixodes ricinus and *Haemaphysalis punctata* are not true insects, but belong to the *Ixodidæ*, a family of the order *Acarina*. On hatching from the eggs ticks bear only three pairs of legs, but when mature they have four pairs. (True insects in the mature state have only three pairs of legs.) The eggs are laid in large numbers amongst damp herbage; the larvæ on hatching attach themselves to sheep or other animals and after feeding fall to the ground and moult, after which they become *nymphæ*. Again they reach a sheep and after feeding for a short time fall away and moult a second time, becoming adults. Once more they feed on the sheep as adults, and after gorging themselves with blood the females tumble to the ground for egg laying. When fasting they are flat, and move with ease, but the body of the female is capable of great distension and is very much larger when gorged with blood. The large ticks begin to be found on sheep about March, and reappear in autumn. They are notably common on the hill pastures of the Border districts and in the Western Highlands, though they occur also in other districts.

Lice.—Lice infesting sheep do considerable harm by cutting the wool and causing itching, irritation and unrest. The head of the louse is large and broad; the body is compressed and wingless. The louse is chiefly found on young animals or on animals in poor condition.

Maggots.—The larvæ of certain flies (especially the green-bottle *Lucilia sericata*) are a source of great trouble and loss to flock-masters during the summer months. The flies deposit their eggs in clusters amongst the wool, and the resulting maggots feed on the live flesh of the sheep. (For particulars of this pest *see* Leaflet 126.)

The operation of dipping is performed in a variety of ways, several types of bath being in common use.

The Hand Bath.

The simplest form of bath is made of wood, galvanized iron, or earthenware, and measures 4 feet in length and depth and $1\frac{3}{4}$ feet in width. In this the animal is immersed by turning it on to its back, and holding its head above water. The advantages of this form of bath consist in its low cost, and in requiring comparatively little liquid to fill it; while its disadvantages are (*a*) the unnatural position of the sheep and the consequent risk of poison "running" into its mouth and nose; (*b*) the laborious and slightly dangerous character of the work for the labourers; and (*c*) the danger of abortion to in-lamb ewes. The hand bath requires more men to work it than the swim bath.

A very convenient arrangement consists of a portable wooden bath 6 feet long, 2 feet 6 ins. wide, and 2 feet 3 ins. deep at one end, the exit slope commencing 3 feet from that end. The exit end is bolted to a specially built, crate-like tip-cart, into which the dipped animals walk to drip. The body of the cart is kept horizontal, the shafts being turned down to the ground, the whole being fixed. The sheep leave at the front end by walking down a slope fixed over the shafts. The whole outfit, not including wheels and axles, may cost about £6 10*s*. When not in use for dipping the cart may be usefully employed as a closed conveyance for calves, sheep, pigs, &c. For a fuller account of this type of bath, together with illustrations, *see* the *Journal of the Board of Agriculture* for July, 1908.

The Swim-Bath.

The swim-bath is made in two forms, being either so narrow (under two feet) that a sheep can only swim forward, or so broad ($3\frac{1}{2}$ feet) that sheep can swim round in it. A bath much used on the larger pastoral farms in Scotland consists of a trough with sloping ends, 33 feet long at the top, 20 feet 6 ins. long at the bottom, and 5 feet deep. The width is about 20 inches, only allowing room for the sheep to pass through the bath in single file. The bottom of the trough is somewhat narrower than the top. The sheep are put in at one end, and after swimming through the bath, pass up the inclined plane at the other end to a dripping pen.

A permanent swim bath constructed of cement, or stone or brick faced with cement, may be built at a cost of about £10. The walls would be 4 to 6 ins. thick, and the bath 3 feet deep, 20 ins. wide at the top and 12 ins. at the bottom, and 12 feet in length. The sloping walk-out commences 6 feet 6 ins. from the deep or "well" end. There is a man-hole on either side, a collecting pen at the one end and a double draining pen at the other. The bath will accommodate two lowland or three Fell sheep, or four to five lambs at a time, and 500 to 600 sheep can be handled in a short day's work. (This bath is also described and illustrated in the *Journal* referred to above.)

The Cage Bath.

A third form of dipper consists of a galvanised tank sunk in the ground with its upper edge flush with the surface. In this a cage is raised and lowered by means of a hand windlass. One sheep at a time walks into the cage, and is lowered into the bath. In due course the cage is raised and the sheep walks on to the draining floor. Under this method the sheep are scarcely handled at all, the labour is easy, and risks of all kinds are reduced to a minimum.

Further information on baths will be found in the Minutes of Evidence of the Departmental Committee referred to below.*

Dips.

In some experiments conducted by Professor Winter, at the University College of North Wales, Bangor, sixteen dips were tested, and of these five (Nos. IV., V., X., XV., XVI.) were proprietary.* The sheep were immersed in an ordinary swim-bath for a period of one minute, every sheep being carefully examined at the end of 24 hours, and again at intervals until shorn a month later. A brief summary of the principal dips employed is given below :—

I.—2½ lb. arsenious acid (ordinary arsenic), 1¾ lb washing soda, per 100 gallons dip-bath.

II.—2½ lb. arsenious acid, ½ lb. good dry caustic soda, per 100 gallons.

III.—As No. I., with the addition of 4 lb. of flowers of sulphur.

IV.—Combination of arsenic and sulphur, dip-bath containing 5 lb. free sulphur per 100 gallons.

V.—Soluble sodium compounds of sulphur, with free sulphur.

VI.—25 lb. of sulphur and 12½ lb. of lime boiled in water until of dark red-brown colour; strain and make up to 100 gallons.

VIII.—Carbolic acid ¾ gallon, soft soap 5 lb. per 100 gallons dip-bath.

X.—A fluid carbolic dip readily soluble in cold water.

XIII.—1 gallon of a mixture of 29 per cent. tar acid, 36 per cent. paraffin, 8 per cent. lanoline, 17½ per cent. anhydrous soft soap, and 9½ per cent. water, in 100 gallons dip-bath.

XIV.—Extract of 35 lb. finely ground tobacco and 10 lb. flowers of sulphur per 100 gallons dip-bath at 110° F.

XV.—Small proportion of tar acid in addition to tobacco and sulphur.

XVI.—A tobacco, soft soap, and sulphur dip.

* Report, Departmental Committee on Sheep Dipping, 1904, Cd. 2258 Minutes of Evidence, Departmental Committee on Sheep Dipping, 1904, Cd. 2259; to be obtained from Wyman & Sons, Ltd., Fetter Lane, E.C. Price 3*d.* and 2*s.* 4*d.* respectively.

Effects of Dips.

Keds.—With the exception of Nos. V. and VI. all the above dips were effective in killing keds, but were less successful in their action on the puparia. The tobacco dips were nearly as active, while the sulphur and arsenic preparations required a little longer time.

As the puparia appear to hatch out about 21 days after being deposited by the female, a second dipping at the end of three weeks would doubtless have a marked effect in getting the sheep clear of keds. By that time the puparia left in the fleece after the first dipping would have hatched out, and as there is no evidence to show that keds produce puparia within three weeks after they are hatched, it would only be necessary for the second dipping to destroy the keds which had appeared since the previous dipping.

It was evident that where some of the poisonous dips were used, a second dipping after an interval of 12 days was injurious to the health of the sheep, so that where a second dipping is desired for the destruction of keds, the proper time would appear to be about three weeks after the first immersion.

Lice.—There is every reason to believe that any dip which is destructive to other parasites is effective also against lice.

Ticks.—Much misunderstanding has arisen regarding the efficacy of dips for ticks, owing to the fact that in the natural course of their life history ticks leave the host whether the latter is dipped or not. Arsenical dips appear to give the most satisfactory results.

Maggots.—Sulphur is indispensable for dips against maggots, as the smell keeps off the fly. Carbolic dips, although they may destroy maggots actually present on the sheep, are practically valueless in warding off an attack. (*See* Leaflet 126.)

General.

Carbolic dips are effective in destroying all sheep parasites, and, when skilfully prepared, leave the wool and skin in a nice condition. The strength should, however, be carefully regulated to prevent irritation of the sheep. Nos. X. and XIII. were found to be the best, though X. discoloured the wool somewhat.

Spirits of tar and pitch oil are apt to discolour the wool and reduce its value.

The arsenic and sulphur dips are thoroughly effective in curing scab and destroying other parasites, but the experiments clearly show that the use of strong dips of this character is attended with some danger when treating sheep affected with scab, especially if they are in low condition or have sores on them. These dips had no bad effects on the quality of the wool. (On the subject of preparing wool for market *see* Leaflet 82.)

Tobacco and Hellebore dips, if properly compounded, may also be regarded as quite satisfactory.

The exact composition of some dips is given above, and in Leaflet 61, but farmers will find it more satisfactory to use one of the proprietary dips now on the market. Those which have been tested by the Board, and approved for use against sheep scab, bear a label to that effect.

The dippers should be instructed to pay particular attention to the upper region of the neck, which often escapes saturation when the swim bath is used. It is advisable to swab this region with dip as the sheep swim through.

Before dipping, all dung-bound wool should be removed by clipping.

Too much care cannot be exercised in keeping the bath free from gross impurities, both by skimming floating particles off the surface, and by changing the fluid at intervals. An old and dirty dip laden with manure encourages rather than retards the attacks of insects.

4, Whitehall Place, London, S.W.
July, 1905.

Revised, July, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 146.

BOARD OF AGRICULTURE AND FISHERIES.

The Value of Records of the Milk Yield of Cows.

The practice of keeping records of the quantity and quality of the milk yielded by dairy cows has made very great progress during recent years both on the Continent and in the United States and Canada. It has also been adopted in this country by the leading breeders of pedigree cows, and to some extent by the more progressive farmers in the south of Scotland, and elsewhere.

The system is of value to the milk-seller, to the butter-maker, and to the breeder, according to the object for which the cows are kept. It enables the milk-seller to know exactly what yield his cows are giving and the quality of the milk given by each individual animal. He can thus identify cows which systematically give a low yield or produce milk of low quality, and, by disposing of them, prevent the loss due to maintaining cows that are not worth their keep. Where milk is made into butter, the importance of obtaining a high percentage of fat in the milk is obvious, while to the breeder the practice of milk-testing is perhaps even more important, as by this means he can select his best cows for breeding purposes.

Simple Records of Milk Yields.

In its simplest form a record of the milk yield of cows may be kept without difficulty, and the small amount of time and trouble involved is well repaid by the value of the information obtained. All that is required is a spring balance to which a pail can be hung. The milk of each cow can thus be easily recorded (in pounds or in pints, according to which figure is preferred) and should be noted on a sheet ruled for the purpose and fastened up in some convenient position. The weight of the pail should be deducted, but balances can be obtained with dials on which the weight of the pail is allowed for. If such a record is kept systematically, an accurate account of the yield of each cow will be obtained. Its value lies in the fact that though in a general way farmers are able to distinguish between the good and bad milkers in their herds, a difference of 100 or even 200 gallons is not so easily appreciated when spread over the whole period of lactation. A difference of 100 gallons at $6\frac{1}{2}d.$ per gallon

represents 54*s*., and it is probably not too much to say that cows in the same herd frequently differ in their annual production by as much as £5 without their owner being aware of it.

If the trouble of recording the milk of each cow daily is felt to be too great, an approximately accurate result can be obtained by recording the yield once a week, and multiplying by 7. Experiments made in Lancashire and in the United States have shown that the error is not likely to be more than 3 per cent.

Testing Milk for Butter-fat.

Though a careful record of the milk yield is of considerable value, it is advisable that the milk-seller should also know the percentage of butter-fat in the milk of his cows. In the majority of cases the milk given by the cows of this country exceeds in butter-fat and other milk solids the percentages specified in the Sale of Milk Regulations, 1901, but it may happen that certain cows in a herd may give milk which does not contain those percentages (3 per cent. of butter-fat and 8·5 per cent. of other milk solids). This is particularly liable to be the case where the milking is done at unequal intervals. The seller of milk containing less than the percentages specified runs a risk of being charged under the Sale of Food and Drugs Acts and the Sale of Milk Regulations with selling adulterated milk. It is therefore of great importance to the milk-seller that he should inform himself by testing at regular intervals (about once a fortnight) whether the mixed milk of his cows is being maintained at a satisfactory level of quality. The morning and evening milking should be tested separately for this purpose. In the event of this mixed sample falling dangerously near the percentages in question a sample of the morning and evening milk of each cow should be taken in order to identify the cows which are giving milk of low quality. Experiments have shown that if a cow is well nourished, no alteration or improvement in feeding will permanently alter the quality of her milk, but in some cases circumstances admit of other alterations in the management of a herd or changes in the conduct of a business which will enable the dairy farmer to avoid the risk referred to above.

Where milk is used for butter-making it is essential that the dairyman should ensure that all his cows are yielding milk with a high percentage of butter-fat, otherwise (unless a very high price is obtained for the butter) the value obtained for the milk is very low. For instance, 3·6 per cent. of fat in the milk is equal to a butter ratio of 1 : 25—that is, every 25 lb. of milk will produce 1 lb. of butter; so that if the butter only fetches 1*s*. a pound, it represents less than 5*d*. a gallon for the milk.

Farmers' Milk Tests at Collegiate Institutions.

Arrangements have been made with most of the Agricultural Colleges and Agricultural Departments of the Universities for determining the percentage of butter-fat in milk for a fee of 6*d.* per sample. A list of these institutions will be found on page 7, while directions for sampling are given below.

It must, however, be understood that :—

a. The report sent will refer only to the percentage of butter-fat.

b. Each report refers only to the sample tested, and implies no guarantee whatever as to the bulk.

c. Each report is supplied solely for the information of the milk producer, and must not be used as evidence in case of any dispute between seller and buyer, or where the quality has been questioned by any public authority.

The directions issued by the institutions must be carefully observed. They require, as a rule, that :—

1. The fee of sixpence should be sent with the sample. (No charge, however, is made by the West of Scotland Agricultural College to farmers residing in the counties contributing to the support of that body.)

2. A stamped and addressed envelope should be sent for the report.

3. Samples should not be sent so as to arrive between Friday night and Monday morning.

4. If it is proposed to send samples periodically, as may be in many cases advisable, the institution should be so informed.

5. The sample bottles should be carefully sealed and packed in accordance with the requirements of the General Post Office, and the postage prepaid.

6. The following instructions as to taking samples should be closely followed.

Instructions for taking Samples.

Samples of milk should be taken in all cases immediately after milking. It is of the utmost importance that the milk which is about to be sampled should be thoroughly mixed, and should not be allowed to stand after mixing before the quantity of the sample is taken.

The mixing may be carried out by agitation with a plunger. The plunger should consist of a circular metal plate, 6 to 7 inches in diameter, perforated with a number of half-inch holes, and attached to a handle sufficiently long to reach the bottom of the milk to be mixed. In mixing the milk the plunger should be pushed to the bottom of the vessel and brought to the top of the milk as rapidly as possible not less than ten times. The position of the plunger

should also be moved from place to place to ensure that the whole of the milk at the bottom of the vessel is thoroughly roused and mixed with the upper layers.

If more convenient the milk in a particular vessel may be mixed before sampling by pouring the entire contents of the vessel into an empty vessel and back again three times.

A. *Testing the milk of one cow.*—All the milk, including the "strippings" drawn from the cow at a milking should be brought together in one vessel and thoroughly mixed. A portion of the milk should then be at once removed with a jug or a dipper and transferred to a clean dry bottle capable of holding at least a quarter of a pint. The bottle should be immediately corked and sealed.

If it is desired to take the sample in duplicate, the whole of the milk required to fill the two bottles should be taken from the mixed milk at one filling of the jug or dipper.

B. *Testing the milk of a herd:—*

(a.) *Where the total quantity of milk from the herd can be placed in one churn, or vessel, or mixing tank.*

All the milk should be placed in one churn or receptacle, and mixed thoroughly, as described above. A sample should then be taken as under A.

(b.) *Where the total quantity of milk from the herd fills more than one churn, and there is no single vessel available in which it may be mixed.*

The milk should be distributed as equally as possible among a number of churns or similar vessels. This may be conveniently carried out by pouring the milk as received from the milking of the herd into as many churns as may be required. The churns should not be filled, but the *same quantity* should be placed in each. If there remains a quantity of milk less than sufficient to fill a churn to the same content as the others, this quantity should be divided as equally as possible among the churns already used. When this has been done the contents of each churn should be thoroughly mixed, and one gallon taken from each. These portions should be placed in another churn or vessel, thoroughly mixed, and a sample taken as under A.

The bottle in which the milk is sent should be full, and a label should be affixed to it, bearing the name of the sender, full postal address, and the date on which the sample was taken.

An important point in connection with these tests for butter-fat is the frequency with which they are required to be made in order to give an accurate indication of the average richness of the milk. Cows vary so much in the amount and quality of their milk from one milking to another that exact results cannot be obtained by testing the milk from one milking at distant intervals. There is little doubt that once a fortnight is sufficient, but if the sampling is only done monthly the error may be considerable.

The expense which would be incurred in sending a large number of samples regularly to the colleges can, to some extent, be avoided by the testing being done at home by the Lister-Gerber testing apparatus, as after the first outlay the actual cost of making the test, apart from the labour involved, is insignificant. The use of this apparatus requires a certain amount of skill and care, but an intelligent dairyman or dairymaid will become expert at it after a little practice.

Co-operative Societies for Milk-testing.

In order to avoid the trouble of milk-testing on a large scale, the Danes some years ago introduced the system of forming small societies of farmers, who combined in order to share the expense of employing an assistant to devote his whole time to the work.* This assistant visits each farm for one day in turn, and makes a careful record of the quantity and quality of the milk of each cow, and also of the system of feeding, and other particulars of the herd. The cost of this work in Denmark is not large, varying from 1*s.* to 2*s.* per cow annually. The assistant, usually a young man from an agricultural school, is paid only a small salary, as the position is regarded as affording an excellent training. The State also makes a grant of about £14 each to the societies.

The statistics available of such societies in Denmark, Germany, and Sweden, show that the average yield of the cows has substantially increased owing to the unsatisfactory animals being gradually discarded.

The great success which attended the efforts of these societies has led to their establishment in other countries, but in Great Britain they have so far only been formed in the south-west of Scotland under the auspices of the Highland and Agricultural Society, which makes a grant towards the cost. These Scottish Associations are generally composed of twelve to eighteen members, each of whom has the milk from his cows weighed and tested, usually by a young man who has been trained in the Dairy School at Kilmarnock. The latter arrives at the farm during the afternoon, and weighs, samples, and tests for fat the milk of the evening and of the following morning, after which he goes on to the next farm. The weight of the food used is also ascertained, and some very interesting information as to the cost of food in the production of milk has been obtained. Thus it has been shown that the system of feeding adopted on some farms costs double as much as on others in proportion to the milk produced.†

Though these appear to be the only British societies established up to the present, the Lancashire Education

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* "Milk Testing and Control in Denmark," *Journal of the Board of Agriculture*, Vol. xii., April, 1905, p. 21.

† *Journal of the Board of Agriculture*, Vol. xiv., September, 1907, p. 321.

Committee have adopted the same system as a means of demonstrating how farmers can eliminate from their herds cows which produce milk of an inferior quality.

Value of Milk Records to the Dairy Farmer.

Apart from the benefits of the practice to the milk-seller and to the butter-maker, the keeping of milk records presents great advantages to the dairy farmer who breeds his own cows.

Milking qualities are largely hereditary, and the progeny of a heavy milking cow are likely to inherit the characteristics of their dam. It is therefore of the first importance that the dairy farmer should have a record of the performances of his cows, and should select the heavy milkers to breed from for his own herd. Dairy qualities are also transmitted through the bull used, and it is equally important to be able to show that he is descended from a heavy milking strain.

The possession of a satisfactory milk record becomes in this way a very valuable asset, not only as a guide to breeding, but also for sale purposes. In Denmark the prices of dairy cows are in many instances regulated by their milking records.

This principle is well recognised in this country in the case of pedigree dairy cattle, but it is capable of a much wider application. By its aid it would be possible to build up a milking strain, the milk records of which would be equally as valuable as a pedigree. This point is mentioned in the Board's Handbook on British Breeds of Live Stock in connection with the non-pedigree Shorthorn, it being pointed out that though it is one of the most serviceable and meritorious of all the numerous breeds of cattle in this country, this dairy breed remains under a cloud, especially with foreign buyers, because it has not got a paper pedigree. What it wants to make it of inestimable value in the United States of America and the more temperate of our distant colonies is a pedigree of performance. The breed has been for a long time subjected to searching selection on the score of merit, and although no written record has been made of it, the record is there nevertheless in its capacity to produce heavy-milking progeny. It would consequently only require the recorded results of a few generations to provide evidence of merit in milking that would generally be transmissible.

It is from this point of view that the Milk Control Associations of Denmark have proved of great service, and as many of them have now been in operation for upwards of fifteen years, a reliable and authentic life-history is available for several generations of the cows belonging to the herds tested. The owner of the herd can produce for the information of a

purchaser a complete record, not only of the production of any particular cow, but of its dam as well, and also evidence of the milking qualities which were likely to be transmitted through its sire. He is in possession, in short, of a "pedigree of performance" in regard to his particular strain of milking cows.*

There is little doubt that this system is worthy of wide imitation in Great Britain, and might, with advantage, be fostered by breeding societies and by local agricultural societies.

Institutions which undertake Milk-testing for Farmers.

Aberdeen, Kincardine, Banff, Elgin, Inverness, Ross and Cromarty.	James Hendrick, Esq., B.Sc., F.I.C., Marischal College, Aberdeen.
Mid-Lothian, East and West Lothian, Berwick, Clackmannan, Fife, Forfar, Kinross, Peebles, Perth, Roxburgh, and Selkirk.	Dr. A. Lauder, East of Scotland College of Agriculture, 13, George Square, Edinburgh.
Argyle, Ayr, Bute and Arran, Dumbarton, Dumfries, Kirkcudbright, Lanark, Perthshire (western district), Renfrew, Stirling, and Wigtown.	Prof. R. Patrick Wright, West of Scotland Agricultural College, 6, Blythswood Square, Glasgow (no charge is made in this case).
Northumberland and Durham ...	The Agricultural Chemist, Armstrong College, Newcastle-on-Tyne (in Term time only).
Cumberland and Westmorland ...	W. T. Lawrence, Esq., Newton Rigg, Penrith.
Yorkshire	Dr. Crowther, The University, Leeds.
Lancashire	The Director, County Farm, Hutton, near Preston.
Cheshire	T. J. Young, Esq., F.S.I., Agricultural College, Holmes Chapel, Cheshire.
Derbyshire, Notts, Leicestershire, and Lincolnshire (parts of Lindsey).	John Golding, Esq., F.I.C., F.C.S., The Chemical Department, Midland Agricultural and Dairy College, Kingston, near Derby.
Staffordshire and Salop	P. H. Foulkes, Esq., B.Sc., Harper Adams Agricultural College, Newport, Salop.
Norfolk,† Suffolk,† Cambs, Northampton, Hunts, Beds, Herts, Essex,† and Isle of Ely.	Prof. T. B. Wood, Department of Agriculture, Cambridge (in Term time only).
Norfolk and Suffolk...	J. A. Smith, Esq., Eastern Counties' Dairy Institute, Ipswich.
Essex	G. Clark, Esq., The County Technical Laboratories, Chelmsford.
Kent and Surrey	The Principal, South Eastern Agricultural College, Wye.

* An account of the effect of these Societies on Cattle Breeding in Denmark appeared in the *Journal of the Board of Agriculture*, Vol. xvi., March, 1910, p. 1002.

† As an alternative, samples from these counties can be sent to the Institutions shown separately.

East Sussex	S. A. Woodhead, Esq., M.Sc., F.I.C., Agricultural College, Uckfield.
Oxfordshire, Bucks, Berks, and Dorset.	R. V. O. Hart-Synnot, Esq., D.S.O., B.Sc., University College, Reading.
Gloucestershire	The Manager, County Council Dairy School, Gloucester.
Somerset	The Head Master, The Shepton Mallet Grammar School, Shepton Mallet.
Anglesey, Carnarvon, Flint, Denbigh, and part of Montgomery.	Prof. Winter, University College of North Wales, Bangor.
Brecon, Cardigan, Carmarthen, Merioneth, part of Montgomery, Pembroke, and Radnor.	J. J. Griffith, Esq., B.Sc., University College of Wales, Aberystwyth.

Milk producers who do not reside in any of the above-mentioned counties can have their milk tested at the Midland Agricultural and Dairy College, Kingston, near Derby, at ninepence a sample.

In the case of many of the colleges, advice as to the course to be adopted to secure a better quality of milk will be sent—if a form which is supplied by the college is filled up, giving certain information respecting the conditions under which the cows are kept.

4, Whitehall Place, London, S.W.,

May, 1905.

Re-written, March, 1911.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 12 leaflets dealing with Farm Animals and Dairying can be obtained from the same address, price 1d. post free.

Leaflet No. 147.

BOARD OF AGRICULTURE AND FISHERIES.

Fences and Hedges.

One of the difficulties with which landed proprietors, farmers, and others interested in estates have to contend is the formation and maintenance of hedges and fences. The difficulty is often increased on estates where everything is done to keep the fences in good order, by neighbours who own boundary fences but pay little or no attention to their maintenance.

Parts of the country are now practically denuded of thorn hedges, whereas a little timely assistance on the part of the landlord and the tenant might have preserved many good thorn fences. The expenditure and trouble necessary to put in a thorn hedge, to erect guard fences, and to keep them in proper condition for twelve or fifteen years (the time it takes to rear a thorn hedge strong enough to turn heavy stock), should be an inducement to all concerned to take care of those hedges which are in fairly good growing condition. Fences erected as boundaries between farms should be exceptionally well kept up, more especially those marking the boundaries of estates.

Thorn Hedges.

There are several causes that tend to produce ill-kept thorn hedges, and they may be briefly stated as follows:—(1) Throwing of several grass fields into one and neglect of the old division fences. (2) Bad yearly switching or dressing of hedges, with little or no attention as to how they are cut or the proper shape they ought to assume. (3) Want of proper protection to fences newly cut and layered. These ought to be protected for at least three years, and be kept free from weeds. (4) Non-fulfilment of agreement between landlord and tenant as to the up-keep of fences. (5) Changing of farm hands, and consequent lack of consecutive management or treatment. (6) Hares and rabbits, where they are numerous, do a considerable amount of harm to quick fences, by barking the stems.

The whitethorn or hawthorn (*Cratægus Oxycantha*) has been proved to be the most useful plant for forming hedges as barriers against stock. Its adaptability to situation and soil are important factors in its favour, and in addition it possesses the all important quality of resistance.

The time it takes to rear a thorn hedge depends on (*a*) the quality and preparation of the soil; (*b*) the situation; (*c*) the care that is exercised in keeping it clean; (*d*) protection

from stock ; and (*e*) the method adopted in training. Before laying out hedges there are many things which ought to be considered. If the proposed fence is intended to divide fields, or to serve as a boundary between estates, it is nearly always advisable that it should be straight. There are, however, certain lines of division which cannot be altered, such as streams serving as boundaries. In laying out fences between estates a give-and-take line may often be advantageously adopted by mutual consent of the landlords concerned.

Soil, Draining and Trenching.—The soil most suitable for the thorn is a strong loam. The land must be thoroughly drained, and one way to carry off the water from the fence is to run a pipe drain 5 ft. or 6 ft. from the fence on both sides. Sometimes it may be only necessary to attend to drains already in the ground. The conformation of the ground does not always admit of the drains being run parallel to the hedge, but the main point is to carry out the work in the way that will best keep the hedge dry.

The ground having been drained, trenching operations can be proceeded with, the bed being kept on the level. The bank formerly so much employed is quite unnecessary in the majority of cases, as its chief object is at the present day fully met by the thorough system of drainage adopted. In running through hollows where it is occasionally difficult to drain thoroughly, the soil may be raised and a drain-pipe put through the fence to allow the water to pass from one side to the other. Hedges should never, if it can possibly be avoided, be planted on these raised beds : the sides get broken down by stock, and the bank is a good harbour for rabbits and other vermin, and the roots are consequently bared and present an unsightly appearance.

Trenching ought to be done in the autumn previous to planting. In making the trench or bed it should be 3 ft. or 4 ft. wide, and 18 in. or 20 in. deep. If the soil is good to that depth, the bottom soil may be brought to the top, the top soil, if grass land is being trenched, being laid in the bottom of the bed. The soil should be thrown up roughly in the middle, to expose it as much as possible to the influence of frost, care being taken to remove all weeds, especially deep-rooted ones, such as docks, thistles, &c., which if left in will be difficult to eradicate without considerable damage to the thorns. Good, healthy, strong plants, which have been previously twice transplanted, should be used to ensure fibrous roots.

Planting.—Before planting takes place the stems should be cut off 2 to 3 in. above the soil line—that is, 2 to 3 in. above the depth at which they stood in the nursery row. Long or damaged roots should be neatly cut back. In fencing pastures there are some advantages in planting thorns in double rows, the rows being placed 8 in. or 9 in. apart, and plants in the rows the same distance, each plant in a row dividing the space between the two opposite in the other row.

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The thorn thus planted is given more room, and the result is the production of strong lateral growth. If a double-rowed thorn fence should in after years, through neglect, assume a spreading habit, one of the rows may be cut off at the base some years in advance of the other to encourage fresh growth ; when strong enough to act as a fence, the other side may be treated in the same way. Care should be taken not to allow a double-rowed hedge to become foul, for there is great difficulty in cleaning out the weeds ; and if there is reason to fear that the hedge may be neglected the thorns are better planted in a single row. In planting hedges on arable land a single row of plants 6 in. to 8 in. apart would be most satisfactory. Having consolidated the soil somewhat in the centre of the bed by treading, the operation of putting in the plants can be begun. It takes two men to put in the plants properly. After the first spadeful of soil is laid on the roots, the plant should be drawn lightly up and down so as to cause the soil to run into the interstices formed by the roctlets. The placing of the thorn being completed, more soil is laid on the roots and carefully firmed round the stems, finishing by drawing the soil to the plants, leaving them just pointing the surface.

There is another plan which has been adopted with considerable success. The stems are left a little longer than is advocated above, and the soil is made to cover the whole of the plant, which is left in this condition until it shows signs of vitality in the spring. The soil is then taken from the plants to the depth of 3 or 4 in., forming a V, with the plant in the middle. The shoots, it is said, come away stronger, and are more numerous than when the thorns are left standing above ground at the time of planting.

Cost.—The cost of trenching, purchasing plants, and planting, runs from 4*d.* to 6*d.* a yard, the cost being principally affected by the nature of the ground. Very often this is not the only expense to be met in putting in a quick fence. Protection rails may have to be erected on one or both sides, and this adds considerably to the initial outlay and up-keep. A three-barred fence, using sawn morticed oak posts and larch rails, can be put up for about 1*s.* 2*d.* per yard, while a four-barred fence will cost 1*s.* 6*d.* per yard.

Protection is absolutely necessary next to pastures, but adjoining arable land this expense is often saved. Temporary protection from the sheep that consume the crops of tillage land must be given, or otherwise the quicks will be damaged, not only by the teeth of the sheep but also by the wool that is left on the lateral growth. One of the greatest drawbacks to the forming of thorn hedges is the fencing required for protection, and the outlay is certainly heavy when it is found necessary to protect the fence on both sides, and occasionally wire-netting must be used to ensure success if rabbits abound. Assuming, then, that protection from stock and rabbits is necessary, the expense works out as

follows :—Trenching, purchasing and planting thorn, 5*d.* per yard ; two guard fences, including cost of erection, 2*s.* 6*d.* per yard ; wire-netting, 6*d.* per yard, making a total expense of 3*s.* 5*d.* per yard. But it is seldom found necessary to go to this expense. The prices quoted are for first-rate material, which ought to last until the hedge is in a condition to act as a fence, and then be of further use for repairs.

Trimming.—Except for cutting back the thorn at the time of planting, a thorn hedge should not be trimmed or dressed until four or five years after planting. The stems of the plants then thicken more than when they are trimmed from the first, and when cut back to, say, 2 ft. from the ground they present a strong appearance. A great many of the thorns will have developed two, three, or four shoots, some of which can be dispensed with, and should be cut near the bottom to encourage further growth at that place.

After first commencing to trim into shape a hedge which is not growing well, it is an advantage to trim every alternate year instead of yearly ; this treatment has a tendency to strengthen it.

The way in which hedges are trimmed determines both their shape and stability. In order to ensure success dressing should be done with an upward stroke, making the hedge wedge-shaped, while there should be no haste to raise the hedge to its full height. Hedges which have been raised too rapidly are often unable to act as a fence owing to the weakness and looseness of growth. Those which are trimmed regularly for many years sometimes get, in spite of attention, so unshapely and unnecessarily large, that it is desirable to rib in, or cut back the lateral growth to the main stem to bring them back to their former shape, and it is equally necessary to encourage growth by cutting back to the base all weakly or suppressed stems. Adjoining pastures, this operation is rather risky unless the fence is protected for a time.

Hedges which are well cared for and regularly trimmed may be trimmed in February if in exposed situations, or at any time from August to February if sheltered. Neglected hedges, however, which require hard pruning, should be taken in hand in autumn in ordinary situations, or in early spring in cold, exposed positions. The whitethorn is very hardy, but might suffer if severe frost followed soon after pruning.

Weeding.—Too much cannot be said in favour of keeping hedges clean, and it is often necessary to clean twice or three times during the year where weeds are troublesome. If hedges are allowed to become very foul there is always a danger of the plants getting damaged in the attempt to root out the weeds, and there is also a great loss of nutriment, to say nothing of the soil thrown off with the

weeds. Weeds also harbour insect pests which may attack the hedge. The first cleaning should take place in spring, before any seeding occurs. On land which is very weedy and of a tenacious character, it is often found that, owing to the great amount of cleaning necessary, the soil on the roots of the plants becomes deficient. This is rarely experienced before the fence is of sufficient size to do without hand weeding, and at this period it is well to add fresh soil, and to keep clean by cutting down the weeds with a sickle twice annually, or oftener if required.

Restoration of old Thorn Hedges.—Some of the important qualities which recommend the whitethorn as a hedge plant are, that it is long lived, and stands cutting even to an old age, and is therefore easily kept within bounds. The cutting and layering of old thorn hedges must be carefully done, and they must be protected from stock until the new growth is strong enough to resist cattle, and until those portions of the fence which it is necessary to layer are firmly fixed in their new position. Cutting old fences which are fairly well supplied with stems all along the line is comparatively easy work, and is successful when it is well done. But when fences with gaps have to be dealt with, greater skill is needed to fill in the gaps with living thorn. A good plan in restoring old hedges is to cut the layers near the ground to encourage growth at the base, allow the fence to grow unmolested for six or eight years, and then cut and lay again.

A chief reason of the non-success of cutting and layering is found in the fact that much of this kind of work is badly done. There is a tendency where there is an abundance of thorns to layer too much, instead of cutting off at the base all the thorns that can possibly be dispensed with, after deciding which of the thorns are to be retained for layering and, in certain cases, for acting as living stakes.

While living stakes are frequently resorted to where suitable wood can be got in the fence, dead stakes are recommended by most expert hedgers. A fence made with dead stakes keeps its shape better than one in which living stakes have been used.

Where rabbits abound, cutting back old hedges to the level of the ground rarely meets with success.

Cutting back and layering, while suitable for most parts of England south of the Tees, is not much practised in the north or in Scotland. In some experiments recently made in connection with the renewing of old hedges in Fifeshire, it was found that shoots half cut through near the ground are apt to die off in this cold northern climate, but the following method of renewing irregular and overgrown hedges proved successful.

If the fence is ultimately required to be 4 ft. high, the hedge should be cut clean across to a height of under 3 ft.,

any supple shoots being tied down to cover as many gaps as possible. The tying should be done with No. 18 galvanised wire, but care should be taken to tie down the shoots loosely, to allow for growth. The hedge being only cut to a little under 3 ft., it is not necessary to keep the roots of the hedge clean otherwise than by cutting the long weeds that might grow up through the naked hedge. In this state the hedge should be left for three years, when it should be switched up, leaving the top shoots. These shoots should be thinned to the required distance, and laid down and tied horizontally across the top of the hedge to cover all blanks. If this single process did not suffice to make a close fence, the hedge could be allowed to grow for the necessary time, the operation being then repeated. The hedge after laying should be perfectly close, and could be kept trimmed every year or every second year according to taste.

The fences dealt with in the experiments were upon arable land under rotation and grazed for two or three years. As the lands are in crop for five or six years, the operation described may be commenced when the grass is broken up, so that by the time the land comes into pasture again the operation should be finished, leaving a suitable fence for stock. It is not, therefore, necessary to protect the hedge against stock during the process of renewal.

Other Hedge Plants.

The Holly is a good hedge plant, and has the advantage of being evergreen, but it grows slowly, and is specially liable to be eaten by rabbits. The soil in which this plant grows best is a sandy loam. It should be planted in May or September, using twice transplanted roots; these should have as much soil as possible adhering to them, and be lifted and planted the same day. Should the roots become dry, watering at the time of planting is necessary. A bed should be prepared somewhat similar to the one advocated for the thorn, and if the soil is thin it would be an advantage to give a mulching of manure. Little attention is required for some years as regards training to any particular shape, beyond what is necessary to check the lateral and top growth of any plants which have for some reason grown faster than the rest, so as to bring the hedge to a uniform height and thickness. Annual trimming with shears, which ought to be done in summer, need not be commenced until the hedge is nearly high enough to act as a fence. The holly being a shade-bearing tree, can be trained into almost any shape, as the bottom growth is not much interfered with by the spreading of the top. It makes a good screen for gardens, orchards, &c., and can be grown to a great height with an unbroken face from top to bottom. The cost is about 10*d.* to 1*s.* per yard when 12-in. plants are used.

The Beech makes a splendid hedge for screening and sheltering, and grows best on a gravelly soil holding plenty of lime. It stands exposure well. Since it is a shade-bearing tree, it can be grown where thorn or any other light-demanding plant would not be a success, while it may be trained to a good height without losing its closeness of growth. The annual trimming induces it to retain part of its leaves during winter, thereby enhancing its value as a shelter. The cost of putting in a beech hedge is from 4*d.* to 6*d.* per yard. Beech ought not to be cut over at the time of planting.

Evergreen Privet makes a nice garden fence, and is easily reared and tended. It may be put in as cuttings, or the cuttings may be allowed to stand two years in a nursery, and then be planted out. In a very short time it will grow into a nice neat fence if cut in closely.

Wire Fencing.

This class of fence is much used in Scotland, and is now owing to its cheapness and durability, becoming more common in southern districts. Often, however, wire fences are erected in positions where they are very liable to breakage. The most suitable places are plantations, roadsides, clumps, and pleasure grounds. If a wire fence has to be erected between pastures—a position somewhat unsuitable for such a fence—a rail should be run along the top in place of wire. This gives stock a better chance of seeing the fence when galloping. The cost of erecting a good wire fence, composed of oak or larch posts, standing 6 ft. apart and using galvanised wire, is 10*d.* to 1*s.* per yard.

Stone Walls.

A stone wall forms a good fence and is durable. The cost varies considerably, owing to the distance the stone has to be carted and the ease with which it is obtained. To build a wall 4 ft. 6 in. high, with two rows of throughs, tapering from 2 ft. to 10 in., and limed top and throughs, costs about 3*s.* 6*d.* to 4*s.* per yard when carting and material have to be paid for. If the cost of carting and material is not considered, then the price would be about 2*s.* per yard.

Creosoted Fencing.

The cost of erecting a fence of creosoted redwood to turn heavy stock is as follows :—Two top rails, 12 ft. by 4 in. by $1\frac{1}{2}$ in., at 10*d.* each ; two bottom rails, 12 ft. by $3\frac{1}{2}$ in. by $1\frac{1}{4}$ in., at 8*d.* each ; two posts, 6 ft. by 6 in. by 3 in., at $9\frac{1}{2}$*d.* each ; erection at $2\frac{1}{2}$*d.* per yard ; making a total of about 1*s.* 4*d.* per yard. It is advisable to obtain, if possible, material free from knots, as the rails are easily broken at the places where the knots are, besides which many of the knotty rails are either cut out of young trees or from the tops of old ones, and are therefore immature, decay sooner, and are

lighter. In erecting a fence of the above material, the rails having the least knots should be nailed on the upper part of the fence.

Seasoning of Fencing Material.

The object in seasoning is to get rid of all the moisture or sap, and to accomplish this various methods may be adopted. The only method referred to here will be that of drying in open sheds, *i.e.*, admitting a free current of air and protecting from rain. In order to check decay, no time must be lost in placing sawn timber under cover. It should be allowed to remain so protected for at least one year, and during this time should be re-stacked or turned over to facilitate drying. In the case of timber which is used for outdoor purposes, the gain from proper seasoning would amply repay any expense incurred in erecting necessary plant.

Durability being a most important quality in fencing material, a primary object must be to obtain matured timber, which is the best to use, whether seasoned or unseasoned. Mature timber contains less sap wood than immature, and there is consequently less shrinkage and less liability to attract organisms which hasten decay.

Preservative Methods.

The common methods are painting, tarring, and charring, but the work should never be done until the timber is seasoned.

The cost of painting rough outside work is prohibitive, but work, such as dressed paling, gates, &c., erected in places where people are liable to come in contact with the woodwork, is better painted than tarred. Tarring is the most common method employed in preserving outside rough woodwork. Gas tar should be kept for some time before using as it improves by keeping. Charring is very useful for preserving posts, as it forms an outer coat of charcoal which is immune to the attacks of insects and fungi, and is almost indestructible when placed in the ground. The disadvantages of charring are a loss of wood and cracking; the charred parts should be tarred over, thus plugging up the external cavities of the wood, and preventing the entrance of air and water.

4, Whitehall Place, London, S.W.,
July, 1905.
Revised, May, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 148.

BOARD OF AGRICULTURE AND FISHERIES.

Planting Fruit Trees and Bushes.

Time of Planting.

November is, in general, the best month of the year for planting fruit trees and bushes. The leaves have then fallen, and the soil is always moist enough, while it is less likely to be too wet than at a later period of the season. Planting may be carried on, however, all through the winter, and in the early part of the spring, before the buds have started in growth, whenever the land is in a suitable condition—that is, is free from excessive wetness and frost.

It frequently happens that apple trees retain their foliage until mid-November, and it is a bad plan to move the trees until the leaves fall. The trees do not suffer, however, if the leaves are stripped off at once when the trees are lifted.

Soil and Position.

Although soils over the Old Red Sandstone, the Greensand, or the Lias, or deep alluvial soils, are among the best for fruit, satisfactory results can be obtained on any land that will grow corn, clover, and potatoes well, or where the elm tree flourishes naturally. Stiff clays, very shallow soils of any class, and burning sand or gravel soils are, speaking generally, to be avoided, though excellent crops of fruit, notably apples and cherries, are produced on such a strong soil as the Weald. Land having a gentle slope to the south is best, and the closer the south-west is approached the more necessary is natural or artificial shelter to protect the trees against gales from that quarter; but there are many good orchards on level plains, and some with aspects which would not have been selected if a choice had been available. A site fully exposed to the south-east renders blossom and foliage liable to injury when the sun rises in a cloudless sky after a frosty night; while basin-shaped hollows, or the proximity of water, should always be avoided, owing to the greater intensity of frost in such places.

Preparations for Planting.

Preparations for planting should be made much earlier than November, as the land must be drained if water is likely to stagnate in it, and it needs to be thoroughly cultivated before the holes for trees and bushes are dug. Land in which an early potato crop, or a crop of peas, has been grown, comes in well for planting, as there is time after getting such crops off the field to allow of the necessary cultivation and the settlement of the soil. Potatoes are usually manured heavily, and when they are raised early

the land is commonly in a friable condition ; whilst the pea crop adds to the supply of nitrogen in the soil.

The first operation should be surface cultivation to kill weeds, followed, if necessary, by the application of a dressing of farmyard manure over the whole of the land. Next come ploughing and subsoiling, unless the land is to be dug with a spade, and in that case what is called bastard trenching is essential. This consists in digging the top spit in the ordinary way, and stirring nine or ten inches of the soil below with a spade or a fork without bringing such soil to the surface. Such work is usually regarded as too costly for planting on a large scale, for which the subsoiling is best done by a steam cultivator, stirring the soil in two operations as nearly to the depth of two feet as possible. Where a steam cultivator is not available, a subsoil plough, following an ordinary plough, is commonly used.

The make-shift plan of merely digging holes for trees in land not deeply cultivated is a bad one, no matter to what depth the soil in the holes is stirred. This is particularly the case where the subsoil is retentive, the holes merely becoming wells for water to drain into.

What to Plant.

Before the holes are dug it is necessary to decide what is to be planted in them. In many recently-planted orchards headed half-standard, two year's feathered, or bush apples, with gooseberries or currants between them, are grown for market purposes. In other cases two year's feathered or half-standard plums have taken the place of apples. Less frequently, tall standard apples, with bush apples or plums or pyramid pears between them, have been planted. Half-standards or bushes are much more convenient for pruning, spraying, and picking than tall standards, and for that reason are to be preferred. In exposed situations they are also less affected by wind, and can often be planted without staking, which is needed where standard trees are planted. If it be intended to cultivate a plantation with horses for some years at least, thus effecting a great saving in the labour of keeping the land clean, half-standards are preferable to bush trees. On the other hand, bush trees on the Paradise stock come more quickly into bearing than half-standards, which are usually on the crab or free stock. Again, both gooseberries and red or black currants become profitable much sooner than apples, plums, or pears, and therefore they are most commonly planted as bottom fruit, when by the time the bush fruits are worn out, or are unprofitable, the top trees will require all the space.

Distance apart, and arrangement of Trees.

The distances desirable between trees and bushes vary with the character of the soil, and, so far as trees are concerned, with strength and habit of growth. But, if horse cultivation is to be pursued this may modify the decision as

to distances. On rich soil, full standards may be planted up to 30 ft. apart each way, whereas 20 ft. may do on poor land. Similarly, half-standards may be 15 to 20 ft. apart, according to the character of the soil and the varieties, while bush trees on the Paradise stock should be 12 ft. apart. The bottom fruit bushes should be planted at equal distances between the trees. For example, if the trees are 18 ft. or 24 ft. apart, the bushes should be 6 ft. from the trees and 6 ft. apart ; if the former are 15 ft. or 20 ft. apart, the latter will be 5 ft. For horse cultivation, however, 6 ft. from plant to plant is preferable to 5 ft.

The difference between planting on the square and in angled form is shown below, + indicating a standard, and o a bush tree :—

TREES SQUARELY PLANTED.

```
+ o + o + o + o + o
o o o o o o o o o o
+ o + o + o + o + o
o o o o o o o o o o
+ o + o + o + o + o
o o o o o o o o o o
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TREES ANGLED.

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+ o o o + o o o + o
o o + o o o + o o o
+ o o o + o o o + o
o o + o o o + o o o
+ o o o + o o o + o
o o + o o o + o o o
```

In the case of planting bush trees, if horse cultivation is to be pursued for a time, no modification from the 12 ft. distance can be recommended, as 18 ft. would be too wide in either direction. For horse cultivation it is of great importance to have the rows of trees and bushes perfectly straight in each direction and the distances precisely kept, in order that the cultivation may be done across as well as up and down. The best way to insure this result is to mark out the field in both directions with a light plough, such as a double-breasted plough used for ridging. This should be done

at the distance of tree to tree, and then a tree hole can be dug at each place where the lines intersect, as shown above. The place for each bush hole can be determined by measuring from a tree, as the trees should be planted before the bushes. Even then, great care is needed to prevent a tree or bush from being put more to one side of the hole than the other, and frequent sighting from at least three trees off is necessary to insure straightness both ways in the rows.

If it is desired to angle the trees, so as to allow a little more distance between them across the rows, a tree and a bush may be planted alternately where the ploughed lines cross, as shown on p. 3.

A good distance for cherries is 30 ft. each way, bush plums or apples being planted between them, to stand until the cherry trees shade all the ground. Raspberries, usually grown by themselves, but occasionally as bottom fruit, may be set in rows 5 ft. apart, with 2 ft. between them in the rows. For strawberries, 3 ft. by 1 ft. 3 in. will do well. Cherries should not be manured heavily at planting time.

Varieties of Fruit to plant.

The choice of varieties is too wide a subject to be fully dealt with here. Some varieties are suitable to certain districts and soils and not to others, so that the novice should always seek local information. A local grower of experience would be able to give good advice as to the varieties which flourish best in his district, and as to the best market sorts. Again, some varieties of apples are best as standards or half-standards on the crab stock, and others as bushes on the Paradise stock. Upon these and other points sound information may be obtained of an experienced nurseryman, or may be found in the many excellent guides to fruit culture. While it is desirable for market growers to plant only a few of the best bearing and selling varieties, in order to have a good supply of each lasting for some time, it is well in starting to plant also a few trial rows of various other sorts, one row of each, with a view of planting extensively in future those which prove the best for the district, or for the local market.

Apples.—Information as to varieties of apples will be found in the Board's Leaflet No. 134 (*Apple Culture*).

Plums of excellent repute for a succession are Rivers' Early Prolific, Czar, Victoria, Belle de Louvain, Pond's Seedling, and Monarch.

Pears are not very extensively planted for market in this country, and those which are grown are chiefly early and not the choicest varieties, as but few of the better class can be relied on for regular crops. Clapp's Favourite is one of the best early pears, and Williams's Bon Chrétien is a

favourite market variety. Hessel is most largely grown in orchards near London and in Kent. Fertility, like Hessel, is a great bearer, and superior to it in quality, but a little later. Louise Bonne of Jersey is one of the most delicious September pears, and a good bearer, but not a strong grower unless on very rich or heavily manured land. Marie Louise d'Uccle, Émile D'Heyst, and Pitmaston Duchess are grown for market successfully in Kent.

Choice pears are best grown as bushes on the quince stock, when Conference, Dr. Jules Guyot, Fondante de Thirriott, Doyenné du Comice, and Durondeau should be added to the above list.

Damsons are planted at the present time mainly as shelter trees. King of the Damsons is perhaps the best variety; but the Worcestershire Prune is commonly grown in the Evesham district, and the Crittenden or cluster damson in Kent.

Cherries.—Among the most important cherries for a succession are Early Rivers, Knight's Early Black, Frogmore Bigarreau, Blackheart, Black Eagle, Waterloo, Amber Heart or Kent Bigarreau, Napoleon Late Bigarreau, Black Turk, and the Flemish Red for cooking.

Gooseberries.—Among Gooseberries, Whinham's Industry can hardly be beaten for fruiting, and Keepsake, Lancashire Lad, Crown Bob, and Whitesmith are other excellent and prolific varieties. Langley Beauty and Leveller are two large yellow free upright-growing varieties, and are to be recommended. Keepsake is the earliest to pick green, and the Yellow Rough pays well to gather for early ripe berries, while the Warrington Red is best for late sale when ripe.

Currants.—The mite has played such havoc in plantations of black currants in recent years that bushes should be obtained only from mite-free nurseries. Baldwin is one of the best varieties, but especially liable to mite or big bud infestation (*see* Leaflet No. 1, *Black Currant Mite*). Boskoop Giant is now recognised as the best and does not take the mite so freely as others. Lee's Prolific is an old favourite, but its berries are not so large as those of Baldwin, and not nearly equal in size to the Boskoop currants. New Red Dutch and Scotch Early Red are also well-known good red currants.

Raspberries.—Superlative is probably the best of all market raspberries, and a strong grower; Hornet is another good variety, superior in flavour but not equal in size to Superlative, nor does it grow so freely. Norwich Wonder and Wisbech Perfection are favourite kinds in some localities

Strawberries.—Among strawberries, Royal Sovereign is now the chief favourite for market production, having superseded Paxton to a great extent, though the latter is still largely grown, as also are Stirling Castle and Fillbasket. Givon's Prolific is a valuable novelty in late strawberries.

In some fruit plantations, strawberries are planted between the rows of trees and bushes, to stand until they are too much shaded, or until their profitable life is ended. This plan prevents horse cultivation, and it is, therefore, preferable to grow strawberries by themselves.

An important point to be considered in relation to the planting of either raspberries or strawberries is whether sufficient hands can be obtained for picking promptly as the fruit ripens.

Planting.

Planting should not be done when the soil is in a wet condition, as it is of great importance to place friable mould over the roots. If the weather is not favourable when the trees arrive, they can be "laid in by the heels" until it is so. The first operation at the time of planting is the trimming of the roots, all parts bruised in the process of raising the trees in the nursery being cut off with a sharp knife. The cut should be made upwards from the base of the roots, so that the cut surface will rest on the soil, and the anchor or lower roots should be shortened.

When the land has been subsoiled only shallow holes are necessary, but they should be at least 3 ft. across each way for a tree and 2 ft. for a bush, in order that the roots may be spread out to their full length. Nothing is more fatal to success than the mere digging of small holes and sticking in trees and bushes so that their roots are doubled up or cramped in space. The Royal Horticultural Society recommend* that the holes to be opened should be "at least 1 foot broader than the roots cover." If the land has not been subsoiled the bottom of each hole should be broken up to the depth of 10 inches, a little of the top spit thrown into the middle and the tree planted on it.

If standards or half-standards are to be planted, strong stakes will be required, not less than 7 ft. long for the former or 6 ft. for the latter. If placed exactly in the centre of each hole the stakes will be in straight lines, and the trees tied to them must be so also. It is much easier to drive in the stakes before planting than afterwards, besides which possible injury to the roots of the trees is then avoided.

In planting, one man should hold and place a tree, spreading out all the roots so that their ends slope slightly downwards, while another spreads finely-divided soil over them, moving the tree gently up and down to work the soil

* Varieties of Fruits, 1906 Edition, Revised, p. 10.

well among the roots. The earth in the hole should be a little higher in the middle than towards the sides, to allow of the roots being spread well without being turned upwards. After some of the soil has been thrown in, upon poor land a forkful of manure may be placed upon it, and the hole may then be filled up, being slightly rammed during the process, and trodden firmly, but not hard, at the finish. Dung should not be placed directly on or in contact with the roots, and in soil well manured for a previous crop manure should not be placed in the holes at all at planting time. It is best used as a mulch in the following summer, but a layer placed round each tree on the surface after planting is of much value. The trees should be so planted that they will be of the same depth in the soil after it has sunk as they were when growing in the nursery. On heavy land it is important to guard against too deep planting. Planting almost on the surface of heavy land, with small mounds of earth over the roots, is sometimes recommended; but this is a questionable practice, as the earth is almost certain to be drawn away from the trees in hoeing, even if it be not washed away by heavy rain, leaving the roots insufficiently covered for a droughty season.

Shelter.

In exposed situations it is of great importance to provide shelter against prevailing winds, and where planting is to be done by instalments, extending over some years, it is advisable to put in shelter trees beforehand—the sooner the better. The Italian poplar is one of the quickest-growing of trees, and for this reason it is extensively used for shelter. Its chief defect is that it is deciduous. On the other hand, evergreens are of much slower growth. The Austrian and Scotch pines are frequently recommended, as they form excellent shelter. A much more speedy grower is *Cupressus macrocarpa*, which is one of the best shelter trees for the south-western counties of England. In the bleaker north it is liable to be killed by frost, and there the *Cupressus Lawsoniana* or Corsican pine may be recommended instead. *Pinus insignis* is useful for Cornwall and Devon. A single row of trees is not a sufficient windbreak where gales are violent, and it is a good plan to plant a triple row: damsons inside, *Cupressus* trees in the middle, and Italian poplars outside.

Besides tall trees as windbreaks, the lower shelter of a dense fence is desirable. On most farms hedges are already provided, and these can be allowed to grow at the top, regular annual brushing tending to thicken those which are gappy or thin at the bottom. For making a new fence quickly, or for filling up gaps, the Myrobalan plum is one of the quickest of growers; it may be made to grow densely by early pruning and subsequent brushing, but it does not like heavy soil. (*See* also Leaflet No. 147, Fences and Hedges.)

General.

With respect to the extent of planting at any one time, it is desirable to point out that the capital required for extensive operations is considerable. It is not only the expense of preparing and manuring the land and the purchase and planting of trees and bushes that have to be estimated. At least as much should be allowed for the annual loss on a plantation before it comes into profit, this usually being five to six years after planting for standards and half-standards. In the meantime the expenses of cultivation, spraying, pruning, manuring, picking, and marketing, with rent or interest on capital, rates, and taxes, will often considerably exceed the returns. No fixed estimate of the amount of capital that must be sunk can be given, as it will vary with the condition of the land, the age or stamina of the trees and bushes when planted, and the care and good judgment exercised in their treatment.

Bush fruit begins to pay the third year, and apples on Paradise stock may give a fair return the second or third year.

It is desirable to warn inexperienced planters against the purchase of very cheap trees and bushes at auctions, or as offered in advertisements, unless they are found, on inspection, to be well up to the mark. Weak or stunted trees or bushes are dear at any price. On the other hand it is not desirable to pay extra prices for large trees or bushes, as those which are two to three years old commonly do best.

4, Whitehall Place, London, S.W.
October, 1905.

Revised, February, 1908.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 149.

BOARD OF AGRICULTURE AND FISHERIES.

Threshing of Barley.

Injury due to bad Threshing.

Complaints are frequently made by brewers and maltsters of the injury done to barley in the process of threshing, owing to the fact that the drum of the threshing-machine is set so close that many of the grains are cracked or broken. The presence of such injured grains greatly reduces the value of the barley for malting purposes, as the broken, bruised or skinned grains fail to germinate, and soon show signs of mould, thus leading to unsoundness in the malt and bad results in the brewery. The injury caused by over-dressing is not limited to grains which are actually broken, as grains closely nipped at one or both ends, or such as have been bruised and peeled, are equally objectionable. In fact, if by too vigorous threshing the husk of the barley is damaged, although the damage may not be apparent, irregularities in the malting, accompanied by the production of mould, are likely to result.

To prevent Injury.

(1.) When farmers commence a day's threshing they should at the outset, and repeatedly during the day, carefully examine the grain. If any signs of injury are observed the concave of the drum of the machine should be slightly opened. It is better that part of the beard should be left adhering to the grain than that any risk should be run of injuring the reputation and value of home-grown barley on account of broken and chipped grains.

In this connection, Mr. Baird, a leading maltster in Scotland, in an article on the Overdressing of Barley, which appeared in the *Transactions* of the Highland and Agricultural Society in 1902, pointed out that if in order to get all the grain out of the ear, especially when the barley is difficult to thresh, the drum and concave are set too close, there is obviously more danger of breaking and "nibbing" than when they are not so closely set.

(2.) A new machine will break the grain more than a machine which has been used for a time and in which the roughness of the beaters has been worn off. On the other hand, when a machine has been much worn, the centre of

the drum and concave having had the most work, in consequence of the feeding being necessarily more in the centre than at the ends of the drum, the space between them is greater in the centre than at the two ends, and if they are set to thresh clean in the centre they will be too close at each end, and consequently damage will occur. This fault can only be remedied by putting on new drum-beaters and concave ribs.

(3.) Great attention should also be paid to regularity of feeding. The mill should be driven at an even speed, and proper care should be taken in the adjustment of the several parts of the machine.

(4.) It is not only in the drum of the threshing-machine that unnecessary damage to the kernel takes place through imperfect setting of the several parts, but also in the barley-awner or hummeler, through which the grain subsequently passes. Here, if the beaters are set too closely, and the barley is roughly handled, "nibbing" will take place.

Different varieties of barley require different treatment, so that those in charge of the threshing should make a point of constantly examining the sample, and if this is injured in any way, of ascertaining in what part of the machine the injury occurs, altering the setting until it is remedied.

(5.) As a further guide in threshing it may be added that on no account should the barley be rushed through the machine, as it is better to be content with a moderate output and a more perfectly threshed sample.

(6.) Heavy bushel-weight is no longer required by maltsters, and such barley does not command a higher price, grain of moderate weight being preferred to a sample of heavy weight. This may be emphasised by stating that barley weighing naturally from 54 lb. to 56 lb. per bushel is preferable to barley weighing 56 lb. to 58 lb. per bushel.

(7.) It is important that the machine should be thoroughly clean in all parts before commencing the day's threshing.

4, Whitehall Place, London, S.W.,
August, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 23 leaflets dealing with the Cultivation of Fruit Trees and Farm and Garden Crops may be obtained from the same address, price 1d. post free.

Leaflet No. 150.

BOARD OF AGRICULTURE AND FISHERIES.

PEA AND BEAN BEETLES.

1. The Pea Beetle (*Bruchus pisi*).

a. Beetle, × 5 (after Curtis). *b*. Infested pea showing position of beetle. *c*. Hole left in pea after exit of adult beetle.

This beetle attacks peas only, although a closely allied species, *Bruchus rufimanus*, attacks the bean in a similar manner. Although there are records of the adult beetle injuring the leafage of young pea plants by feeding on the leaves, yet it is the larva or grub which is the real cause of the damage complained of in connection with this insect. The grubs live in the seed and the result of their work is that the seeds may not germinate, or if they germinate the plants from them may be weakly. Inferior peas imported for feeding birds, pigs, &c., are frequently very badly infested and help in adding to the numbers of the beetles and in spreading them. In other countries, *e.g.* Canada and the United States, *Bruchus pisi* has occasioned much loss.

Description.

The beetle is oblong-oval in shape and black in colour, with a brownish or brown-grey pubescence. The four basal joints of the antennæ are red, as are also the shanks and tarsi of the two front pairs of legs. The thighs (femora) of

the front legs are black, or almost so, whereas in the allied *B. rufimanus* the thighs of the front legs are red. The thorax is slightly narrowed in front and has a distinct white spot behind. The wing covers are rather short so that the hinder part of the abdomen is exposed; this exposed part has a greyish-white pubescence, with dark spots, of which two large ones at the tip are marked. The hind legs are longer than the others and have the femora stout and toothed.

The larva is whitish-yellow in colour, fat and wrinkled. When newly hatched from the egg it has three pairs of small legs, which are afterwards lost. The scaly head is provided with gnawing jaws.

Life History.

The adult beetles lay their eggs on the pea pods when these are very young. The larva or grub on hatching bores into a pea and here finds nourishment sufficient to develop it to its full growth. When full grown, the larva pupates in the pea, having first eaten its way to the outer coat of the pea, so that when the beetle is mature after pupation and is ready to issue it has only to break through this thin skin. Beetles may issue in the autumn and pass the winter in some place of shelter, or they may issue in granaries and stores and shops during or after the winter, or from the peas after these have been sown. The beetles fly well and can pass to other pea crops.

2. The Bean Beetle (*Bruchus rufimanus*).

This beetle has habits similar to those of *B. pisi*, inasmuch as the grubs live in the seed,—in this case in the bean—where their presence is harmful because of the interference with and possible prevention of germination.

Description.

The beetle is about one-sixth of an inch in length. Black in ground colour, with a pubescence of brown hairs, it has a great resemblance to *B. pisi*. The Bean Beetle however can be distinguished by the thighs of the front legs, which are red, and also by the fact that, the exposed tip of the abdomen being nearly covered with white-grey pubescence, the dark spots characteristic of *pisi* scarcely show in *rufimanus*, or may not show at all.

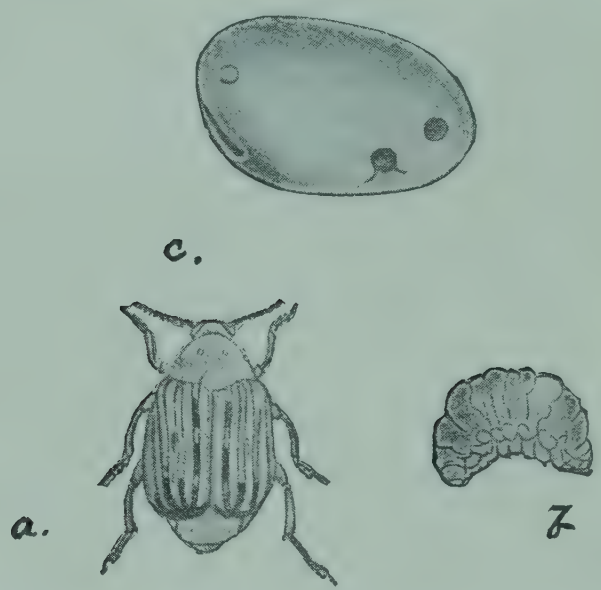
Life History.

The beetles after pairing lay their eggs on the very young pods in the field, making their way into the blossom for the

purpose. Out of each egg hatches a whitish wrinkled grub which bores into a bean, nourishing itself till full-grown on the reserve matter in the seed-leaves. More than one grub may be found in a bean, two and three being very common numbers. The full-grown grub pupates in the bean, and in the spring, or earlier, the adult beetle emerges. The round hole shows the place of emergence; in beans still containing the beetle a little round patch on the outer skin of the bean marks the place where the beetle lies.

General Preventive and Remedial Measures.

(1).—Peas containing the pest should not be sown. It has been stated that the attacked peas can be separated from the



a. Beetle, × 5. *b*. Larva, × 5. *c*. Bean showing issuing beetle.

healthy by placing the sample of peas in water, when the healthy ones will sink while the infested ones float. This statement is not wholly trustworthy. In experiments with sound and attacked peas it has been found that healthy sound peas sank at once, but that peas with holes in them from which beetles had issued, and those with the outer skin broken but with the beetle still *in situ*, might float for a short time, but ultimately they all sink. On the whole, peas with the outer skin unbroken and containing the beetle continue to float.

(2).—The best mode of killing the pest in the pea or bean is by fumigating these with bisulphide of carbon. The method is to enclose the peas (or beans) to be treated in an air-tight box or chamber, and then to place some bisulphide of carbon in a saucer, or saucers, or shallow dishes laid *on the top* of the peas (or beans) and allowed to remain for 48 hours. If large

quantities of peas or beans are being dealt with 1 lb. of bisulphide of carbon will do for each 100 bushels, or where smaller quantities are to be treated 1 ounce of bisulphide of carbon for every 100 pounds. This treatment is best applied as soon after harvesting as possible and when the temperature is not too low. Bisulphide of carbon fumes are poisonous and easily inflammable; they should therefore not be breathed by the operator, nor should a naked light of any kind be brought near them.

(3).—If at the time of sowing live beetles are noticed in the peas, the beetles will be killed if the peas are dipped for 5 seconds into boiling water. The peas so treated may be sown after being passed through cold water.

(4).—If infested peas and beans be placed in a closed jar or other vessel the beetles will in due course issue and will die without further harming the seeds. The seeds could then, if desired, be sown in the next season, but they cannot be relied upon to produce strong plants.

4, Whitehall Place, London, S.W.
November, 1905.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 151.

BOARD OF AGRICULTURE AND FISHERIES.

Cleanliness in the Dairy.

Milk is perhaps at once the most nourishing and the most delicate of all foods; nourishing because it supplies all the constituents necessary to support life, and delicate because in practice its character gradually changes from the moment it leaves the udder of the cow. These changes are chiefly induced by micro-organisms; and as cleanliness is the main factor by which the number and species of such organisms may be kept under control, cleanliness in the handling of milk and its products is of the utmost importance.

Except that portion first drawn from the teat, milk as it exists in the udder of the cow may be considered to be practically free from germ-life. After reaching the milker's pail, however, it usually contains a considerable number of those minute forms of life known as germs, bacteria, or microbes. With proper precautions perfectly sterile milk may be drawn from the udder of a healthy cow, but in ordinary practice milk is more or less exposed to bacterial contamination, and this is the reason that souring and other changes take place.

If the very best milk for keeping purposes is required that first drawn from the udder should not be mixed with the bulk, as it always contains injurious bacteria. Milk from cows which are obviously unhealthy should never be used for human consumption, but may be given to poultry, calves, or pigs *after boiling*. Pure, clean raw milk from *healthy* cows may be considered much better for general consumption than milk which has been pasteurized or sterilized, especially when consumed while still warm.

Of the organisms which find their way into milk it may be said that they belong to the smallest forms of plant-life, which find milk to be a very suitable food and a medium in which they multiply rapidly, the increase being especially rapid when the milk stands for a time in a warm place after being drawn from the cow. There are many species of these organisms, all of which are more or less distinguishable either by their form, their habits of growth, or the effects which they produce. The products of these organisms have a peculiar chemical action upon one or more of the constituents of the milk which may affect the whole. For

To face p. 2.

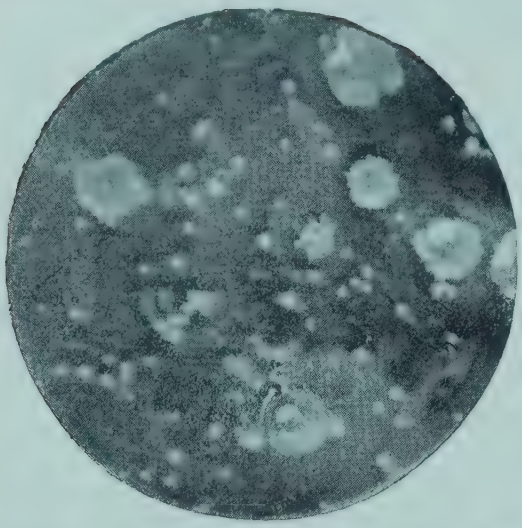


FIG. 1.—Photograph of a gelatine plate exposed for one minute in a badly ventilated cow-shed.

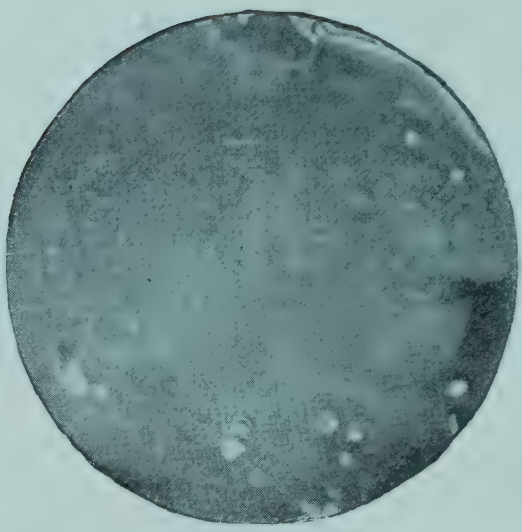


FIG. 2.—Photograph of a gelatine plate exposed for one minute in a well-ventilated cow-shed.

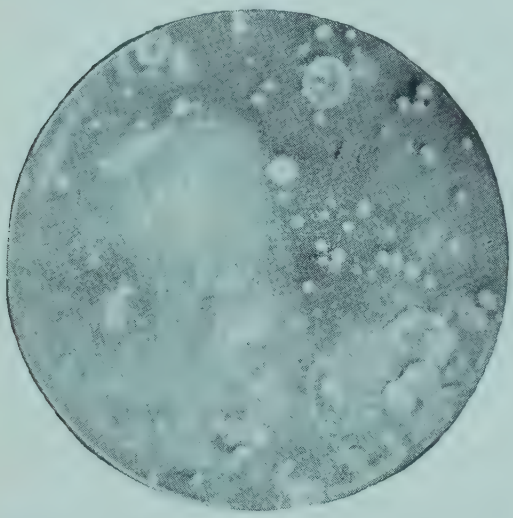


FIG. 3.—Gelatine plate exposed for one minute during milking under a dirty cow.

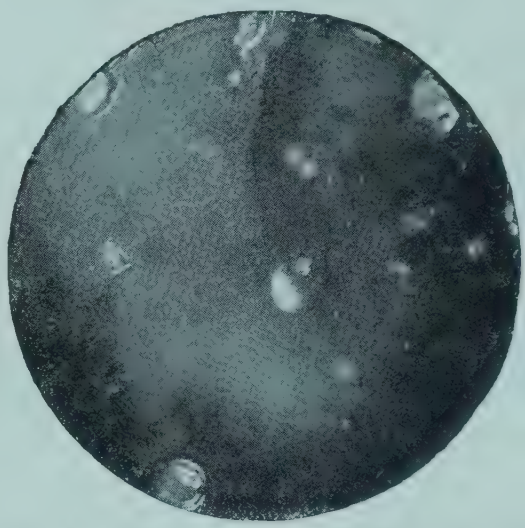


FIG. 4.—Gelatine plate exposed for one minute during milking under a clean cow.

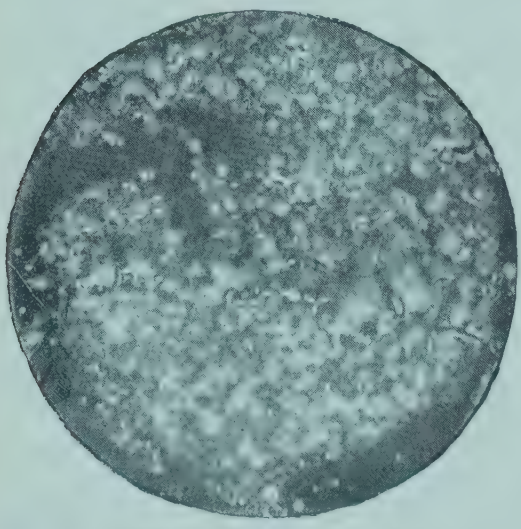


FIG. 5.—Plate culture made from milk drawn into a dirty pail.

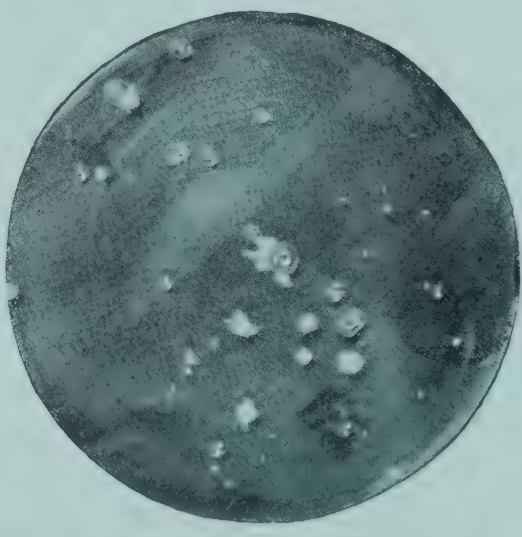


FIG. 6.—Plate culture made from the same quantity of milk drawn into a clean pail.

example, a lactic bacterium secretes a substance which acts on the milk-sugar, thereby producing lactic acid; this acid in turn acts on the casein, forming curd. The objectionable flavours that are so frequently found in milk, butter, or cheese, are also usually due to various specific organisms.

Sources of Bacterial Contamination.

The chief sources of contamination of milk are dirt and dust on the cow, the milker, the air, the water supply, the hay, and the dairy utensils. The cow herself is one of the most fruitful sources; not that she secretes milk containing germs, but because these germs exist on the hair which covers her body, and many of them during milking are in some way carried into the milk. A cow kept in a dirty, badly-kept or ill-ventilated byre is rarely clean; her exterior, especially about the udder and hind-quarters, becomes more or less covered with dust and dirt, on which germs multiply, consequently increasing the number of organisms which fall into the milker's pail. The milker's hands and clothes, which in many cases are none too clean, are also fruitful, and at times dangerous, sources of infection.

The atmosphere of a cow-byre, moreover, is in too many cases confined, and consequently impure; such an atmosphere contains a large number of bacteria, which, being slightly heavier than the air, gradually settle down, and some of these are conveyed into the milk or into the utensils waiting to receive it.

Milk readily absorbs bad flavours and odours from surrounding strong-smelling substances, and proximity to anything of such a nature should be avoided.

Finally, the dairy utensils are frequently a source of contamination, either owing to improper cleaning or because they are left after cleaning in places where they are exposed to infection. Dairy utensils should, wherever possible, be perfectly tinned; they should be as few in number as convenient; and they should be simple in construction. For example, the Danish style of milk can, with close-fitting lid which *throws off* rain water is very much better than the ordinary English railway "churn."

Figures 1–6 illustrate the very material differences which exist between dirty and cleanly cows, pails, and byres. The plate cultures derived from the impure sources contain many more "colonies" of organisms than those derived from the cleanly sources.

Cleanliness in the Management and Housing of Cows.

Efficient ventilation is, perhaps, the first essential to a good cow-shed or byre. A properly ventilated cow-shed is one in which fresh air is constantly supplied without

causing a draught. There are various ways of providing such a condition, but an ordinary cow-shed should provide an air space per cow of not less than 600 cubic feet nor more than 850 cubic feet, for below the minimum limit efficient ventilation may cause draughts, and above the maximum the temperature, which should be about 56° to 58° F., is apt to fall too low. The walls, beams, and rafters should be regularly swept down and frequently lime-washed ; above all, cobwebs and dust should never be allowed to accumulate. The cow's bed must be kept clean at all times, and the manure and soiled bedding should be removed from the shed at least twice each day. Any manure adhering to the cow after she has been lying down should at once be removed. During the winter, when she passes most of her time in the shed, the cow should be brushed down each day after milking. Where this is done the bacterial contamination of the milk is sensibly decreased, but cleaning and brushing should neither take place when milking is actually in progress nor immediately before.

The hair on the udders and hind quarters of the cows might usefully be clipped in autumn when first taken into the stalls at night, or as they calve. Clipping the udders has been practised on one farm for thirty years, while the hind-quarters have also been clipped for several years, and the plan has been found a great aid to cleanliness. When a power clipper is used it is not so tedious a matter as may be supposed. In the case referred to about 200 cows are dealt with in this way.

The gangway and gutter behind the cows should always be kept clean, and it is important that they should be in their cleanest state at milking time. The material composing the floor of the gangway and gutter should be impervious to moisture, otherwise it may harbour organisms which, if carried into the milk, may be the cause of considerable trouble. Openings of drains from cowsheds should always be placed outside the building.

It is not desirable to confine the cows entirely in the sheds during the winter ; they should be given at least an hour in the open each day, for few things are equal as disinfectants to daylight and exercise.

Cows should on no account be allowed to consume hay or dusty fodder during the time milking is in progress, as both contain countless organisms.

Too much attention cannot be given to the drinking water. It is to be regretted that in many cases the cows have access only to a stagnant pond, into which they must wade before sufficient depth is attained to enable them to drink. When drinking, cows are apt to void excreta, with results that may be imagined should such material fall

into the water, as it too often does. Such a state of affairs should be remedied at once, and ponds should be fenced in, the water being drawn by a hand pump into a drinking trough outside the fence. Even if the droppings of cows are excluded from the drinking place, stagnant water is certain to be crowded with bacterial life, so that, apart from the risk to the cow's health, the chance of trouble with the milk is greatly increased by allowing the cows access to such a pond. There are many ways by which the bacterial life of a stagnant pond may gain access to milk, but probably the most common way is by means of the organisms carried out of the water on the exterior of the cow, and which at milking time may fall into the milk. The evil of this will be realised when it is remembered that among the bacterial life of any pond may be found, almost without exception, many organisms capable of bringing about injurious changes in milk, butter, or cheese. The ideal watering-place is a running stream of pure water so protected that cows cannot wade into it, or a trough through which such water passes. Where no such stream exists every endeavour should be made to approach the ideal as nearly as possible, and if it is necessary for the cattle to drink water that is more or less stagnant, matters should be so arranged that they can obtain what they require without being able to stand in the water.

It is well to avoid milking cows while they are dripping with rain water. This is probably a frequent source of bacterial contamination.

Dairy farmers, and especially those engaged in cheese-making, should be most careful not to allow poultry in and about the cow-sheds, or to have access to hay and straw used as food for the cattle. Droppings of poultry are a little recognised but fruitful and frequent source of contamination. They teem with bacteria injurious to milk, and are almost certainly often responsible for excessive fermentation or "sponginess" in cheese curd.

Cleanliness in Milking.

If the best is to be made of the milk after it has been drawn, it is necessary to observe the strictest cleanliness in connection with the operation.

In order to prevent contamination of the milk everything should be at rest within the byre at milking time, that is to say, there should be no shaking of bedding or feeding of the cows. The whole place should be clean and sweet, and quiet. Shortly before milking begins someone with a clean, rough, dry cloth should be sent to wipe each cow's udder. If any cow's udder is found to be soiled in such a manner that it cannot be cleaned in this way it should be washed. The practice of washing the udder was attended with no ill

effects in the Yorkshire experiments.* After washing the udder must be carefully dried, otherwise the cow might get cold in one or more quarters of the udder.

Each milker should thoroughly wash his or her hands and arms before commencing to milk, and particular care should be taken to see that the milker's clothes are clean and suitable for the purpose. This may be best assured by insisting that each one wears a smock or blouse which has not been too long absent from the wash-tub. All milkers and employés should be healthy and free from infectious disease.

As soon as the milk of each cow has been drawn, it should be taken outside the cow-shed and passed through a strainer, consisting of muslin resting on a fine wire gauze, and then removed to the dairy as quickly as possible. The use of thick heavy cloths for straining purposes is to be condemned, as they are liable to be very imperfectly cleansed. Numerous cases of "fishy" flavour and rapid souring in milk have been traced to the use of such cloths. Straining should take place before cooling, which should be done as soon as possible after milking, and invariably in a pure atmosphere. It is advisable to rinse the cooler with boiling water and then with pure cold water immediately before the milk is passed over it. The milk should be cooled to 50° F. It is a great mistake to allow milk to stand about in the cow-shed, as is often done, for this only serves further to contaminate it.

Milking with wet hands is an objectionable practice. The cows should be stripped of their milk thoroughly and quickly by dry-milking. Apart from the fact that no dirt is so difficult to remove from milk as that which enters in a liquid or semi-liquid form, the act of wet-milking leaves the teats covered with a film of milk on which germ-life immediately begins to multiply, and as that film of milk dries the germs become more or less firmly attached to the teats, only to be removed and washed into the pail at the next milking. In dry-milking, it is sometimes an advantage if a little vaseline is rubbed on the milker's hands before beginning work.

Experiments* with two of the best modern milking machines showed that they were a source of great contamination, owing both to the difficulty in cleaning them and to the sucking in of air and dust when the cups fall off.

Importance of Cleanliness.

(1.) *In Dairy Utensils.*—Vessels used for the reception of milk should be absolutely unabsorbent, otherwise it is

* *See* "Report on an Investigation as to the Contamination of Milk," carried out on behalf of the County Boroughs of Bradford, Hull, Leeds, Rotherham and Sheffield, and the Administrative Counties of the East and West Ridings of Yorkshire, 1908. Copies of this Report, price 2*s.* 6*d.*, can be obtained from the Clerk of the Council, County Hall, Beverley.

impossible to clean them thoroughly. If, for example, warm milk is put into a dry wooden vessel, the heat of the milk causes the air in the wood to expand, and so drives out a portion of it; and afterwards, as the milk and the vessel cool down, milk is sucked into the wood to replace the air previously expelled. When milk has once entered into wood it is a most difficult matter to remove all traces of it, the result being that the portion which almost invariably remains acts as a food for germ-life. To obviate this, wooden milk vessels, if used at all, should always be thoroughly saturated before being used to receive milk, by first placing them in hot, and afterwards in cold, water.

In the majority of dairy utensils tin is the surface with which the milk comes in contact. Such utensils are excellent, provided that all joints are properly made and that all parts are readily accessible for cleaning; all should be cleaned immediately after use, and on no account should milk be allowed to dry upon them. The cleansing may be best accomplished by first washing them in cold or slightly warm water, afterwards using hot water and a stiff brush, which is much better than a cloth. The utensils should finally be rinsed in boiling water. If steam is available, and the vessels can be put over a steam jet, so much the better. The hotter the final rinsing or steaming, the greater the likelihood of all forms of germ-life being killed. After cleansing, milk vessels should be left in an airy position with the mouth or opening turned downwards, but in such a manner that the air has unrestricted access. Parts which are not easily accessible should be washed with lime water occasionally.

(2.) *To the Milk Seller.*—To both wholesale and retail milk sellers all forms of germ-life are objectionable, for if they wish to retain their customers it is necessary to produce milk which not only meets the requirements of the standard of quality, but retains its freshness as long as possible. The dairy or shop should be pure and clean, and well ventilated, but protected from dust, &c., while water employed for any purpose should be quite pure. The keeping quality of milk is mainly determined by two factors: first, the amount of germ-life contained in it; second, the temperature at which it is kept. The latter factor is, in reality, only a part of the first, since the rapidity of the multiplication of germ-life is dependent on temperature. For this reason milk to be sold as fresh milk or milk which has to travel any distance, should invariably be run over a cooler in order to lower its temperature, and should be kept at a temperature not exceeding 50° F., ice being used if necessary.

In the retail trade all stale milk, or milk left unsold, should be kept quite apart from fresh or warm milk. All milk to be sold should be kept well stirred and the vessels

kept covered. If the trade is in *warm fresh milk*, then especial care is necessary in its production and management.

During hot or dusty weather, floors and their surroundings should be sprinkled with clean cold water.

(3.) *In Butter and Cheese-making.*—It is not going too far to say that cleanliness is absolutely essential to the successful making of first-class butter and cheese. In butter-making pasteurization of milk is possible, but for the cheese-maker it is not practicable. For cheese-making, therefore, especial care is necessary in the production and handling of the milk. Unlike the milk seller, to whom all forms of bacterial life are objectionable, the maker of dairy produce has to depend on certain forms of germ-life to perform vital functions in the processes by which milk is transformed into butter or cheese. In cheese-making, milk may be compared to a field free from weeds, the cheese-maker sowing in the milk cultures of the ferments or bacteria which he wishes to grow, and which produce the desired flavour. Butter-makers often nullify all anterior efforts to avoid contamination by washing butter in the churn with impure water, or by packing butter in bad paper or in unsuitable packages. Yet experience teaches that wherever uncleanliness exists there also will be found a large number of germs which, by their action, are almost certain to prevent the successful manufacture of dairy produce. Indeed, it not infrequently happens that, owing to the uncleanly management of the cows, uncleanly milking, or uncleanly utensils, the possibility of making the finest butter or cheese has been destroyed before the milk has even reached the dairy.

4, Whitehall Place, London, S.W.
July, 1905.
Revised, March, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 12 Leaflets dealing with Farm Animals and Dairying may be obtained from the same address, price 1d., post free.

BOARD OF AGRICULTURE AND FISHERIES.

Bacterial Disease of Tomatoes.

BACTERIAL DISEASE OF TOMATOES.

This disease has long been known in France, where, during certain seasons, it has assumed the proportions of a destructive epidemic. A single example was received at Kew some years ago for identification, since which time until the present season its occurrence in this country has not been noted. Quite recently, however, examples of the disease

have been received from three widely separated localities, which suggests that it has invaded this country in earnest.

The symptoms are very marked and cannot be confounded with those of any other tomato disease at present known. When the tomato is about the size of a marble a minute blackish patch first appears at the base of the style. This patch gradually increases in size, retaining a circular outline, until eventually the entire fruit is reduced to a blackish, soft decayed mass.

Experiments have shown that infection takes place during the flowering stage, and that the bacteria causing the disease are deposited on the stigma by flies visiting the flowers.

The stigma appears to be the only vulnerable part under ordinary conditions; nevertheless, if bacteria from a diseased fruit are introduced into the flesh of a healthy tomato at any point of its surface by means of the point of a very fine needle, infection follows.

This disease does not appear to be influenced to any extent by the forcing method of cultivation commonly followed, as it has been observed in a house where the temperature was kept comparatively low.

When the disease appears all diseased fruit should be removed as quickly as possible, and not be allowed to decay and liberate the bacteria present in the tissues. Insects should also be excluded by using an insecticide. This last act would necessitate artificial pollination with a camel-hair brush.

4, Whitehall Place, London, S.W.,
October, 1905.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Storing Turnips.

The main reason for storing turnips is to protect them against damage by frost, though protection against ground game, rooks and wood pigeons, which may be very hard on roots exposed during winter, is also an important object in some districts. Not only should a good system of storage secure these ends, but it should also protect the roots against decaying and becoming too dry.

Methods of Storing Turnips.

The more important methods of preserving turnips over winter are as follows :—

1.—In large heaps, whose length and breadth will depend on the quantity of roots to be stored, but whose depth should not exceed $3\frac{1}{2}$ ft. The sides are covered by some 12 in. of straw, overlaid by 4 in. of soil on the sides exposed to the prevailing winds, though 3 in. of soil will suffice on the other sides. The top of the heap is covered by 6 in. of straw kept in position by poles, branches, &c. Old straw ropes removed from stacks that have been thatched may be usefully thrown over the straw. Soil should not be spread on the top of the heap, as it gets washed through amongst the roots and dirties them.

2.—In oblong heaps, like large potato pits or clamps. The base should have a breadth of 7 ft., and on this the roots are piled, gradually contracting to the top like the roof of a house. The whole is afterwards covered by some 12 in. of straw, overlaid by 4 in. of soil on the side exposed to the prevailing wind. On the sheltered side the covering of soil should not exceed 2 in. in depth. Many farmers do not place a complete covering of soil on the sheltered side, but only a spadeful of soil on every square foot. The ridge of the heap is, in any case, left clear of soil, so that free ventilation is secured. This style of heap requires more covering in proportion to its contents than the last, but under no system of storing are the roots better preserved.

3.—In small heaps, equally distributed over the field where the roots were grown. Each heap usually contains about 30 cwt., but in some districts, heaps containing only about half-a-ton of roots are formed, in which case, if the

crop is a good one, no carting is necessary, the roots being simply thrown together by hand. The size of the heaps should be regulated by the size of the flock consuming them, the object being to provide a day's supply in each heap. Thus, with a flock of 200 sheep getting 20 lb. per head per day, about 35 cwt. would be daily required, and this would approximately represent the contents of each heap. The troughs would be moved each morning to a fresh heap, and thus the field would be evenly manured. Should the turnips in these heaps be required within a few weeks of storing, they are usually only covered by the tops, kept in position by a few spadefuls of soil, but for longer storage a covering of straw and soil is necessary. Turnips seldom go wrong in such heaps, which have the additional advantage of being quickly formed. They are specially useful for roots that are intended for consumption by sheep in spring on the land where the crop was grown.

4.—Laying two rows in one, and ploughing in, is an excellent method of storing roots on light dry land. Under this system the roots are not only well protected, but they are also placed under conditions that admit of their growing considerably if the winter is mild. The method of procedure is as follows :—The row is divided into four equal lengths, and a worker is assigned to each. An ordinary single mould-board plough opens a deep furrow close to the first row, throwing the soil outwards. The first worker then proceeds to lay the roots (with tops and tails attached) of the two adjoining rows into the furrow, and the plough on returning throws the earth back on the roots, leaving only the tops of the leaves exposed. Other two rows are then similarly dealt with, and so the work proceeds across the field. In spring, when required, the roots are lifted by ploughing up, dry weather being selected for the operation.

5.—If labour is scarce or work is pressing, considerable protection may be given to growing roots by merely running the double mould-board ridging plough between the rows. In this way the roots, if not very large, are fairly covered, though not so thoroughly as by the previous method.

6.—" Planting," as it is called, is practised locally in the North of England, and is regarded as the best way of preserving turnips for the use of lambing ewes. The turnips grow considerably when stored in this way, and in spring possesses a well-developed top, which is considered excellent for the production of milk. A dry well-sheltered stubble field, or a grass field that it is intended to break up in spring, is selected, and in October or early in November the roots are carted to it and placed in a single layer in their natural position, without topping or tailing. No protection is given, except along the sides, against which a furrow is laid. The only drawback to the system is that it entails the use of a large area of ground.

7.—A favourite system on the Borders, where turnips are wanted for ewes in spring, is to cart the roots, with tops and tails attached, to a grass or stubble field, on which they are laid what may be called "cart-thick," that is to say, about 2 ft. deep. By means of a strong rake or muck-hawk the roots are levelled out, care being taken to get the tops of the uppermost roots on to the surface. A furrow run round the clamp is sufficient protection. Roots stored in this way are found to be specially juicy and fresh in spring, and this system of storage has the additional advantage of being rapid and economical.

Points to be observed in Storing Turnips.

The following points should be generally observed in storing turnips :—

a.—A dry open situation should be selected on which to place the heaps. Although proximity to a wood or hedge may secure shelter from cold wind, roots often keep much worse under such circumstances than in an open exposed place.

b.—The roots should be dry and clean when carted. If topped and tailed, the operation should be conducted so as to injure the bulb as little as possible.

c.—The turnips should be well matured before storing. This is indicated by the lower leaves being yellow.

d.—It is a good plan, weather permitting, to leave the roots lying in the field, after topping and tailing, for three or four days before carting. This hardens the skin, and brings them into better condition for storing.

e.—Unless frost threatens, soil should not be put on the heaps for at least a week after the roots are carted. This permits of the circulation of air and escape of moisture.

f.—A word of warning must be uttered as to the danger of spreading finger-and-toe by means of stored turnips. Roots with any suspicion of the taint of this disease should not be consumed on tillage land, but should be carted on to permanent pasture. Further information on this subject is contained in Leaflet 77.

4, Whitehall Place, London, S.W.,
August, 1905.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 154.

BOARD OF AGRICULTURE AND FISHERIES.

Foot Rot of Sheep.

There has been, and still remains, among flockmasters, shepherds and others a good deal of diversity of opinion as to whether foot-rot of sheep ever constitutes a contagious disease, *i.e.*, a disease communicable from a diseased sheep to a healthy sheep, or not.

This difference of opinion appears to be mainly due to the fact that almost any diseased condition affecting the feet of sheep, associated with lameness, is usually classed under the general and ambiguous term foot-rot, and in that way non-contagious affections of the feet of sheep, causing lameness, have supported the view of some observers that foot-rot of sheep is not a contagious disease.

Non-contagious Foot-sore.

It is important to recognise that in a flock of sheep several animals may be simultaneously lame from injury to the feet, and the disorder show no tendency to spread through the flock. Such a condition, however, is not true foot-rot, although the injured feet may present ugly sores. It would be better described as foot-sore.

The non-contagious form, or foot-sore, which is due to injury to the foot, has its starting point usually in the horn itself. The horn may be decayed, broken, cut or bruised, and, through the opening in the horn, soil and filth gain an entrance and set up inflammation of the sensitive structures of the foot, from which pus is usually discharged.

Among the conditions which predispose to this form of foot-sore may be mentioned the continual grazing of sheep on low-lying marshy pastures where the grass is long, particularly during prolonged wet seasons and neglect of attention to trimming the horn, which under such adverse conditions becomes overgrown, gives an uneven treading surface, and is very liable to become soft and even decayed. Injuries may be inflicted by the animal stepping on sharp or rough objects, such as sharp stones, glass, nails, thorns, &c., and by over-trimming of the feet. They may also arise from travelling sheep for long distances on hard roads, or from anything which causes a breach in the horny foot, or bruises the sensitive foot, especially when the horn is worn or thin.

Symptoms.

The non-contagious foot-sore is the commoner condition met with, and it is not unusual to find one or more sheep in a flock affected. Although lameness may not be a marked symptom from the first, yet it is usually the first indication to the shepherd that there is anything the matter with the

foot, and by this time in such cases, the lameness denotes that inflammation and suppuration have set in.

It will be observed, with perhaps rare exceptions, that in this non-contagious affection the disease has commenced at or near the under surface of the foot, and that the destructive process extends from below upwards. If pus forms and remains imprisoned within the horny box it will burrow and work its way towards the softer structures of the coronet as a way of exit, because the softer structures offer the least resistance to its progress. The foot becomes swollen round the coronet; it is hot and tender, and one or more small abscesses may appear on the coronet or heels. These abscesses burst, and discharge thick pus, which is frequently mixed with a little blood. The parts may continue to discharge pus, or they may heal up, but even when the outer wound is apparently healing and is closed by a layer of coagulated exudate on its surface, the pus may again be imprisoned, with the result that abscesses appear at other parts of the coronet. Providing there is an exit for the pus at the lower surface of the foot these secondary abscesses will not occur, since the pus, as it is formed, is continually discharged from the opening, which affords a natural drainage to the matter within the foot. If after the injury an outlet through the horn remains for the escape of pus, the case may recover in a few days without any treatment. On the other hand, if the breach in the foot is too small and does not allow the free escape of the pus, suppuration continues. Granulation tissue and new horny material are formed, and the former grows out from the sensitive parts in the form of what is commonly called proud flesh, from which a continual discharge oozes. The sore bleeds easily, and the foot becomes distorted.

Treatment.

By carefully trimming the foot, cleansing the wounds with antiseptics, applying a dressing if necessary, and removing the affected sheep to drier pastures, the flockmaster will enable many cases promptly to recover. In those cases where the injury has been aggravated by extensive suppuration the feet require careful and repeated individual attention. It will be found that although the non-contagious affection is the commoner, it usually affects only a comparatively few animals in a flock, unless they have all been subjected to like conditions. There is no evidence of the spread of contagion from sheep to sheep, and frequently only one foot is affected.

Contagious Foot-rot.

Contagious or true foot-rot of sheep is quite a different form of disease to the foot-sore already described. In this country, where the flocks enjoy freedom from such veritable

plagues as foot-and-mouth disease and sheep-pox, true (contagious) foot-rot stands as one of the most serious diseases that exist among sheep generally, but it is a disease which is amenable to treatment, and can be prevented. If sheep-owners, therefore, appreciate the contagious nature of the disease and adopt effectual measures to prevent its introduction into a flock, or promptly combat it when introduced, they will be well repaid for their trouble.

Experiments have demonstrated the infective nature of the virus or poison of the disease by the application of the infected matter from diseased sheep to the feet of healthy sheep, and by the association of healthy sheep with diseased animals. The disease may affect sheep on dry or wet pastures if the infective agent be present.

It is admitted by those who are acquainted with the diseases affecting the feet of sheep that in some cases of foot-rot, especially in advanced cases, the diseased conditions may be so similar in appearance to foot-sore, that a differential diagnosis is very difficult ; but by carefully considering all the circumstances, and by examining the fellow sheep, especially the more recent cases of disease, one will find that in foot-sore the trouble begins in the horn at the lower part of the foot.

Contagious foot-rot is primarily a disease affecting the soft structures of the foot. Any diseased condition of the horn itself is secondary, and is brought about by the separation of the soft from the horny structures through the agency of micro-organisms and the fluids exuded. The disease spreads from sheep to sheep, causing much lameness, loss of flesh, and even death from emaciation. If the disease appears in a flock of in-lamb ewes it is a still more serious matter, as proper treatment cannot be carried out without danger, owing to the pregnant condition of the ewes. In such instances the disease persists until the lambing season commences, and often spreads rapidly to the new-born lambs.

Apart from the adverse influence that wet seasons and damp low-lying pastures may have upon the horny structures of the feet, grit and dirt may work their way into the cleft of the foot and produce a wound. If the soil is contaminated with the virus that produces foot-rot, the disease will soon appear among the flock. It may, however, attack sheep with apparently firm horn and well trimmed feet.

Symptoms.

Lameness is usually the first symptom observed, and on examination of the affected foot a small, moist, unhealthy looking, spot-like sore will probably be found between the toes. The part is inflamed, hot and tender, and when it is manipulated the animal shows signs of pain. There is little or no appreciable swelling of the coronet at this stage. The

disease rapidly extends under the horny box, and if a little pressure be brought to bear on the inside of the foot a slight dirty fœtid discharge will be observed oozing from the edge of the horn around the ulcerated spot. The discharge is never very great, but is always foul smelling ; in fact the fœtid smell is often detected before any gross lesions have been discovered.

The disease progresses from above downwards, between the sensitive structures of the horn and the hoof. When the horn is pared away the diseased parts are found bathed in the fœtid discharge, and the greater portion of the foot may be involved. In some cases the disease extends from the primary seat of the disease to the more important tissues of the foot, injuring the ligaments, tendons, and even the bones.

In protracted or severe cases the foot may be greatly swollen, very tender, and hot. The upper part of the toe is widely separated and the points turn inward, giving the appearance of a club. The animal is in great pain when weight is placed on the affected limb. Abscesses form in the soft tissues of the foot and burst outwardly around the coronet, leaving angry discharging wounds. One foot is usually affected at the outset, but the disease frequently appears in two, three, or even all four feet. In the latter case the animals are unable to move about in search of food. They may be seen feeding on their knees, or lying down feeding on the grass around them. In cases associated with much pain, and where three or four feet are affected, the animals refuse to feed, rapidly lose flesh, and may develop diarrhœa. Such animals become extremely weak. They present a dejected and emaciated appearance, and may die. The various stages of the disease can be seen in one flock. Granulating tissue or proud flesh and new horn-like tissue may grow out from the wounded surfaces. In the early stages of the disease the hoof itself appears normal, but as the condition advances the horn becomes broken and decayed, and if the feet have not been attended to, the whole toe may be cast. During hot weather the condition is aggravated, and deaths are more numerous from the fact that the fœtid discharge attracts flies, and maggots subsequently develop in the wounds. An affected animal may become fly-blown on every part of the fleece which has come in contact with the discharges, and under such conditions it soon succumbs.

Prevention.

It has been said that a shepherd has no right to have foot-rot among his flock. Providing ordinary care is observed the disease should at least not get beyond control. Although the best plan to prevent the introduction of the disease is to avoid bringing suspected sheep on to clean pastures, it is not one which can always be carried out. Attention must especially

be directed to fresh arrivals. In the first place it is necessary to examine any sheep which may fall lame, and any sheep which are not lame but are noticed to show wounds or sores around the hoof or over-grown horn.

1. Periodic inspection, examination and trimming of over-grown feet is a practice to be recommended, and upon the slightest indication of disease affecting the skin between the toes, the affected sheep should be isolated and treated, and the remainder put through a bath containing one of the preparations given below as cures for foot-rot.

2. In the case of sheep bought in a market, or taken to a market and brought back, or any fresh arrivals, they should whenever possible be isolated and the feet of each sheep examined. Isolation should be continued from three to four weeks, as disease might appear after an interval of two or three weeks, although the sheep appeared apparently free from disease at the time of arrival; or as a precautionary measure after examination the sheep should be put through one of the specially constructed shallow baths containing one of the preparations recommended below, on two or three occasions during the first week or ten days after arrival and before mixing with the other stock.

3. The shepherd should always wash and disinfect his hands after examination of the recently imported stock before attending to any of the old stock, and the same remarks apply after the examination of any individual suspected case.

4. It is advisable to afford contaminated pastures a rest from sheep until a winter's frost has intervened.

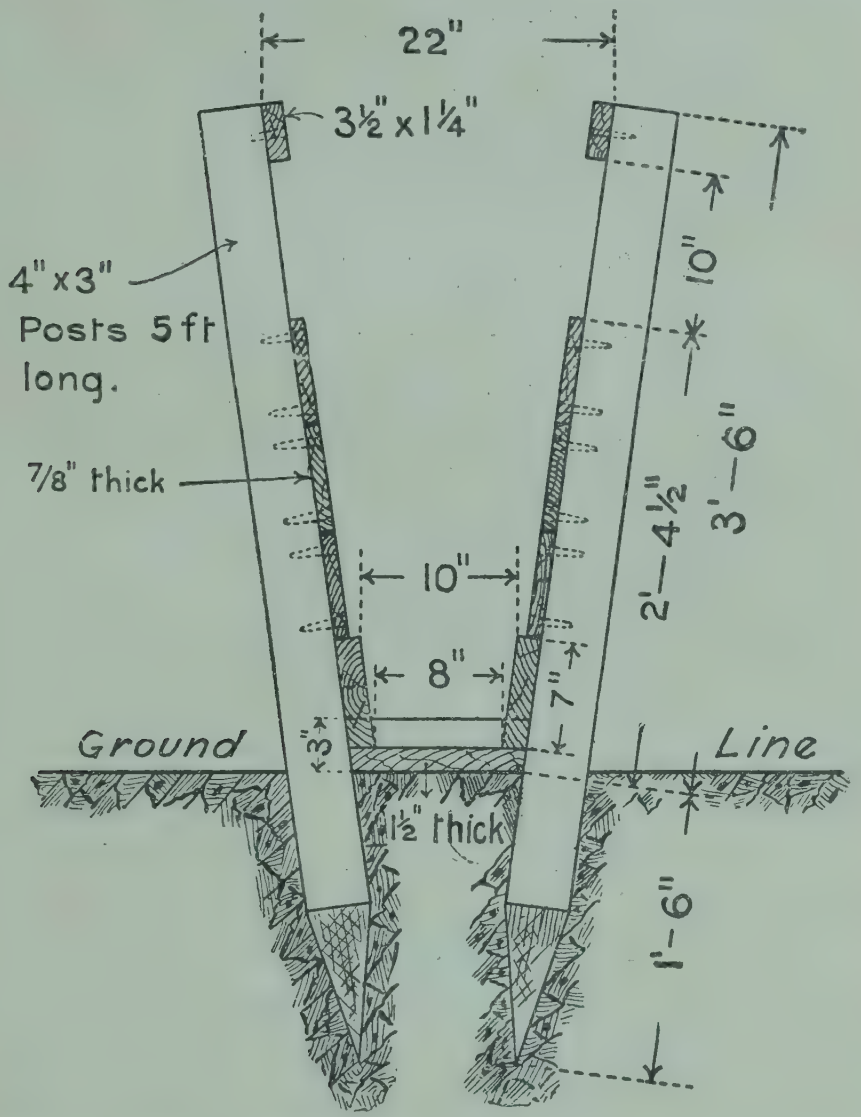
5. Attention must be given to the sheep fold and other pens, which should be thoroughly and effectually disinfected, and the manure and a few inches of the surface soil should be removed and ploughed into the land.

Remedy.

1. In the first place examination of the entire flock and separation of the healthy from the diseased animals should be carried out. The apparently healthy sheep should daily, or every second day, be put through a shallow bath or trough containing some suitable preparation, and the treatment may be advantageously continued for ten to fourteen days after the last case is detected.

2. It has been observed that a sheep may apparently recover from foot-rot without treatment, and the disease may break out again in the same sheep after an interval of several weeks. The second attack may be even worse than the first, but the animal may eventually recover without treatment, or it may die. Treatment, however, is necessary to avoid loss, and prompt measures will materially assist in arresting the spread of the disease to other members of the flock. The earlier the cases are recognised and treated, the more readily and certainly will they yield to treatment, and

aggravated and advanced cases—usually the result of neglect—should rarely occur. Everything possible should be done to prevent the disease extending into the deeper structures of



Foot-Rot Bath.—The bath, of which this is a vertical cross-section, may be made of wood or concrete, and should be about 16 ft. long. The width at the bottom should be 8 in., the sides about 7 in. high, sloping outwards, and if made of wood, boards about 1½ or 1¼ in. thick should be used. The ends should be 3 in. deep, or a little more than shown in the sketch, but deep enough to retain the solution while allowing the sheep to step over them easily. The bottom of the trough, if of wood, should have cross pieces nailed or screwed on at intervals of about a foot to prevent slipping. The floor of a concrete bath should be supplied with transverse grooves.

The sides above the trough should be nailed to posts 4 in. by 3 in. and 5 ft. long, driven firmly into the ground, 4 ft. apart. The run thus made should be wide enough to allow the sheep to walk freely through, and a width of 18 in. at 2 ft. from the ground will be found sufficient even for in-lamb ewes.

the foot, as these cannot be effectively treated without permanent damage to the foot. After thorough cleansing of the affected foot, all detached horn should be freely but carefully

removed, so as to expose the affected sensitive surfaces. Skill and patience must be exercised in paring away the horn of the foot, and the operation should not be carried out in the somewhat rough and careless manner that is adopted by some shepherds. It is imperative to expose all the diseased tissue, and the more advanced and neglected the case the greater will be the labour required. The exposed diseased parts should be thoroughly cleansed with suitable remedies by washing, or by standing the patient in a bath for several minutes. All granulations or fungoid growths should be removed with the knife or snipped off with scissors.

3. It is important to remember that all removed particles of horn or other tissue should be destroyed, buried or disinfected, as such material may serve as a means of further spreading the disease.

4. Whenever the cutting has been deep or the exposed surface is extensive, a piece of clean tow, previously saturated in some antiseptic solution, should be applied, and kept in position by a properly adjusted bandage.

5. Advanced and severe cases, implicating deep structures of the foot, will require more constant attention and repeated treatment, such as cutting away as much of the diseased tissue as possible at each inspection, cleansing and disinfecting, and finally covering the parts with antiseptic powder and bandaging to keep out both soil and filth. In the case of in-lamb ewes every care should be taken in handling the ewes, and when individual treatment is deferred until after lambing, all the flock should in the meanwhile be put through the shallow bath (mentioned below) in the ordinary way at frequent intervals.

The Use of the Foot-bath.

It was noticed some years ago that the ordinary process of dipping sheep had a curative effect on foot-rot, and the good results were ascribed to the action of the poison on the cause of the disease. Arguing from this it appeared probable to the Board of Agriculture and Fisheries that beneficial results would follow the walking of affected sheep through a solution of poison just deep enough to cover the hoof. In practice this was found to be the case.

In order to test the effects of such treatment on a considerable scale the Board, early in 1904, distributed 30 baths (16 feet by 1 foot), each accompanied by 1 cwt. of copper sulphate (bluestone), amongst a corresponding number of sheep farmers in Great Britain. The instructions were to walk the sheep once a month or oftener through a 5 per cent. solution of the copper sulphate (1 lb. in 2 gallons of water), after having cleaned and dressed the hoofs in the case of a bad attack.

Reports from most of the recipients were received, and they were quite unanimous in ascribing much benefit to

the use of the bath. It would appear, however, from the information to hand, that still better results (especially where it is a case of curing rather than preventing) will be got by using a 10 per cent. solution (1 lb. of copper sulphate to 1 gallon water), and, as stated above, the sheep should be put through the bath at frequent intervals.

Although the Board have only experimented with copper sulphate, they are aware that other substances are used, *e.g.*, 3 oz. arsenic, mixed with 3 oz. washing soda and boiled in 2 gallons of water; or 1 part of commercial sulphuric acid to 10 parts of water. Arsenical and other sheep-scab dips may also be used, but it is doubtful whether any substance is more effective than copper sulphate, which is comparatively safe and easy to use.

Summary of Directions for using the Foot-bath:—

a.—Bath of wood or concrete, 16 feet long and 8 inches wide (12 inches is unnecessarily wide), sides sloping out, ends 3 inches deep, provided with cross pieces or grooves to prevent slipping, side fences close boarded and to slope out so as to admit of the sheep walking easily through. (*See* Sketch, p. 6.)

b.—Solution to consist of 1 lb. copper sulphate in 1 gallon of water or, if prevention only is aimed at, half this strength will suffice. Time to be allowed for thorough solution.

c.—Copper sulphate to be bought under a guarantee of purity (98 per cent.), and if possible in the powdered state, not in large crystals.

d.—Sheep if badly affected to have their hoofs pared before being put through the bath.

e.—A day when the grass and soil are dry to be selected.

f.—Copper sulphate and most of the substances used being poisonous, a cover for the bath to prevent stock drinking the solution may be an advantage. In any case the bath must be well fenced in.

g.—If ewes with lambs at foot are treated, they should be put through very quietly so as to prevent the solution getting on to the teats, and thus into the mouths of the lambs.

h.—Sheep with long wool should also be put through very quietly, or otherwise the solution may, under certain circumstances, discolour the wool.

4, Whitehall Place, London, S.W.
September, 1905.
Revised, August, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Larch Canker (*Dasyscypha calycina*).*

This destructive parasite is present in greater or less quantity depending on local conditions, wherever the larch (*Larix europaea*) grows. In this country it also occurs on the Scots pine (*Pinus silvestris*), the silver fir (*Abies pectinata*), the Corsican pine (*Pinus Laricio*), the Swiss Stone pine (*P. cembra*), and the Japanese larch (*Larix leptolepis*).

The fungus is a wound-parasite; in other words, it cannot gain an entrance into the tissues of a living tree except through a wound. The wounds ordinarily occurring in nature through which infection takes place, may be grouped under five headings:—(1) Wounds caused by wind, or by snow resting on the branches; (2) cracks caused by late frosts; (3) gnawing of the bark by rodents; (4) numerous punctures made by the proboscides of the larch aphides (*Chermes laricis*), and possibly the nibbling of the bark by the fungus fairy fly, *Caecilius flavidus*†; and (5) wounds made near the base of the stem in planting.

The general appearance of the fungus, and the injury and resin-flow following its attack, are clearly shown in the accompanying illustration.

As a broad rule, it may be stated, that when trees under ten years of age are attacked by canker, they are either killed outright, or are so deformed that if they continue to grow, they are of very little value for timber. The reason is that in the case of seedlings or very young trees, the main stem is the part usually attacked, whereas in older trees the bark of the trunk becomes so rigid that it is impervious to the punctures of aphides or to injury by late frosts; and the only chance of infection is when branches are broken off, or more or less cracked at the point where they leave the trunk.

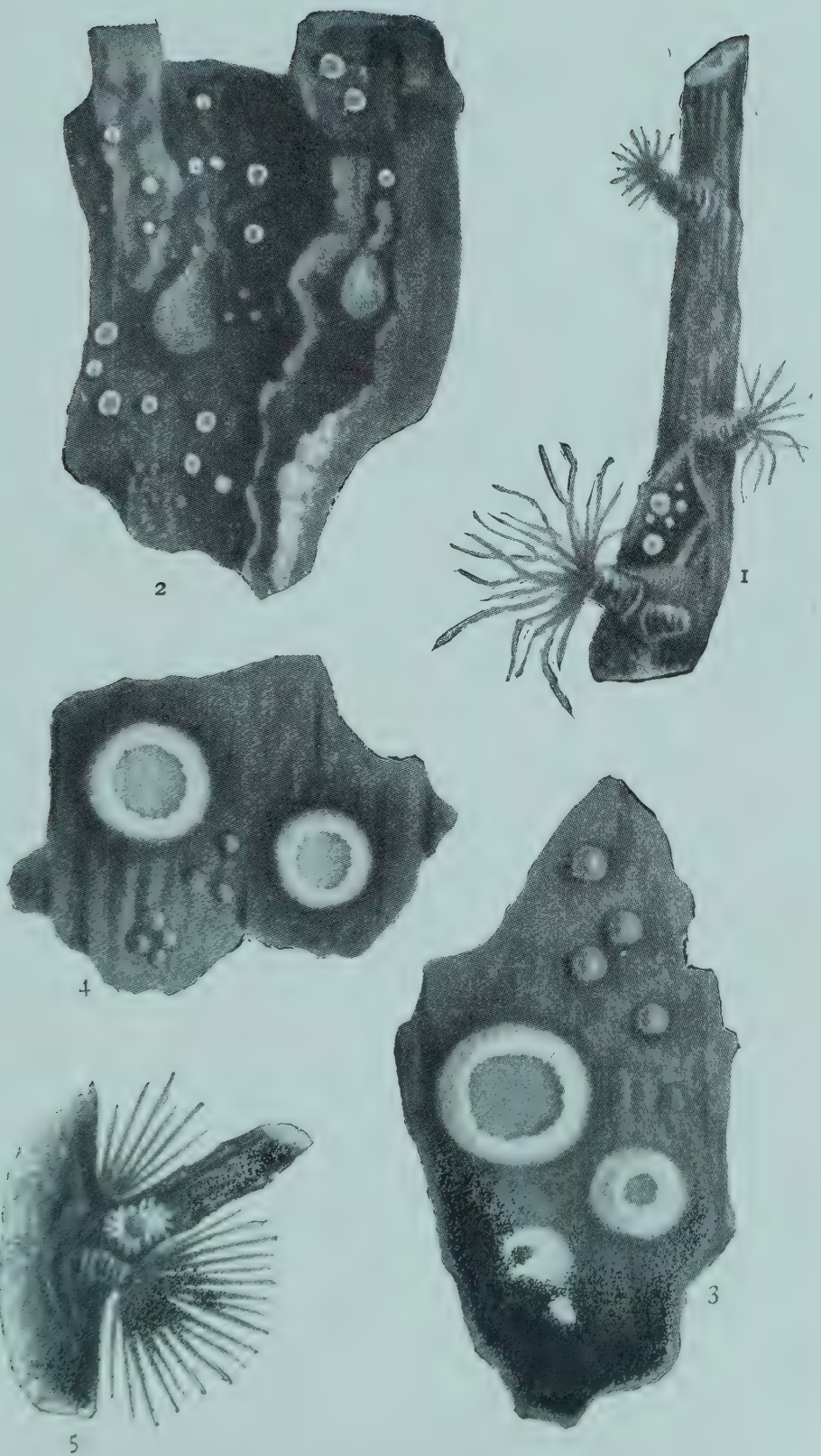
When a young tree is once attacked it very rarely recovers, as the mycelium spreads in the tissues and starts new wounds at some distance from the original point of infection.

Methods of Prevention.

(1.) As a safeguard against inoculation taking place through fissures in the bark caused by late spring frosts, it is

* A more detailed account of this disease, illustrated by one coloured and two other plates, appeared in the Board's *Journal* for September, 1902.

† See *Journal* of the Board of Agriculture, December, 1907, p. 551.



LARCH AND SPRUCE CANKER.

advisable not to form seed-beds nor plant larch in low-lying damp positions, where not only are the plants most exposed to frost, but the conditions favour the presence of the aphis.

(2.) Perhaps the larch aphis* can best be combated by spraying during winter, or when the larch is in resting condition and has not burst its buds. Paraffin emulsion should be used, and the object is to destroy the hibernating aphides. A paraffin emulsion used successfully in winter against hibernating generation on the spruce was composed of 3 lb. of soft-soap dissolved in 2 quarts of boiling water ; while this was still boiling hot, 1 pint of paraffin was added and the whole thoroughly churned. This was diluted with 5 gallons of soft water before use.

For use against the larch aphis in spring and summer a dilute paraffin emulsion would be effective.

(3.) The rank growth of grass and weeds round young trees greatly favours the development and spread of canker, by keeping the trees constantly moist.

(4.) Trees that are badly diseased should be removed and burned.

(5.) Great care should be taken not to injure the bark of young plants when lifted from the nursery, or in planting, as is often done when the turf or soil is pressed firmly round the stem by the heel of the planter.

(6.) A practice which has been generally recommended is to mix the larches with some dense-crowned species (spruce, silver fir, Douglas fir, or beech), the intention being to surround each individual larch with other species immune to the disease. Should the parasite appear on any particular tree, the chances of the spores spreading to other trees of the same species would be reduced to a minimum. Although such a system has undoubtedly proved an advantage to the larch, it has not in all cases sufficed to protect this tree against disease.

(7.) A system which promises to provide a satisfactory solution of the difficulty has for some years been practised by Mr. Munro Ferguson, of Novar, in his extensive woods in Ross-shire. Pure larch woods are planted, and when the trees are 16 to 20 years old all are removed except the soundest and most promising, of which 300 to 500 are left per acre. These trees are the picked stems of the 3,000 or 4,000 originally occupying the ground, and measure up to 51 ft. in height and 4 ins. to 8 ins. in diameter at breast-height. Stems that are sound, or fairly sound, at this stage are not likely to suffer much from disease in later life.

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* The aphis on the larch is a stage in a life-cycle which begins on the spruce. This should be borne in mind in the treatment of aphis on the larch.

The thinning in such a system is done as early as possible in autumn or winter, and this is followed by knocking off all the lower dead branches of the trees that are retained. The "top and lop" of the felled larches, together with the dead branches cleared off the standing stems, are collected into small heaps and burned. Without loss of time the area is then stocked with an underwood of a shade-bearing species,—e.g. *Thuja gigantea*, hemlock spruce, Sitka spruce, silver fir, Norway spruce, beech, &c. (This system is described at length in the *Journal* of the Board of Agriculture for March, 1906.)

Description of the Figures.

1. Portion of stem of a young larch, showing a small canker-wound with the fungus. Nat. size.
2. A small but characteristic canker, with the fruiting fungus present. Nat. size.
3. The two forms of fruit of the canker-fungus. Enlarged.
4. *Dasyscypha resinaria;* a fungus, forming canker on the spruce fir.
5. Portion of a larch branch showing the white flocculent tuft with a central drop of sap, which is constantly to be found near a "foundress" aphis with eggs. Spores of the canker-fungus often germinate in these drops of sap produced by the aphis, and start a canker spot.

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The Board of Agriculture and Fisheries would be glad if creipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 156.

BOARD OF AGRICULTURE AND FISHERIES.

Hedgerow Timber.

Species.

At the present time the bulk of the hedgerow timber south of the Trent consists of English and Wych elm, oak, and ash. Of these the first-named is the most frequent species from Warwickshire southwards, except in certain districts which are characterised by stiff, sour clays, or by very poor or high-lying land, such as the Downs or Wolds. On clay land, or in districts which have only been cleared of natural woodland within comparatively recent times, the oak and ash are usually plentiful, while the Wych elm is abundant in Essex. These last three species also form practically the whole of the ordinary hedgerow timber in the Midlands and North of England, while sycamore also becomes more plentiful towards the North. Where other species occur, such as beech, black Italian poplar, &c., it may be taken for granted that they have been planted.

Advantages and Disadvantages.

Taking English hedgerow trees as a whole, there are three fairly distinct points of view from which they may be judged: 1st, their value as an ornamental feature of the landscape; 2nd, their importance in providing shade and shelter from hot sun, or from cold or strong winds, for men, live stock, or crops; and, 3rd, their value as a source of timber.

The ornamental features of hedgerow trees depend almost entirely upon the suitability of the soil and situation for the species grown. Shapely and well-developed trees, whatever the species may be, cannot fail to improve the landscape and render an otherwise bare or uninteresting country more or less picturesque.

The importance of hedgerow timber in providing shade and shelter is difficult to estimate with any degree of accuracy. There can be little doubt, however, that hedgerow trees act as wind-breaks and diminish the evaporation of moisture from the surface of contiguous fields. A district thickly studded with such trees, therefore, should be warmer in winter and less affected by summer drought than one practically treeless. To the dairy farmer and stock breeder, therefore, hedgerow trees should, in general, be more beneficial than harmful, though the fact is not to be overlooked that sheep suffer more from foot-rot on pastures that are much shaded. To the arable farmer, hedgerow trees are rarely of much benefit, except in the

way of acting as general wind-breaks, for they cause the unequal ripening of crops by shading the ground, while their roots rob the soil in their neighbourhood and cause a reduced yield, and with fields of small acreage this may constitute a considerable loss.

Hedgerow timber in general is grown under two great disadvantages: 1st, height-growth and the formation of long straight boles are interfered with by prevailing winds, and by the absence of competition between individual trees; and, 2nd, the unrestricted development of side branches, tends to the production of coarse, knotty timber. These disadvantages are more or less common to all hedgerow trees, but they are very much greater with some species than with others. An ideal hedgerow tree may be said to be one which is little affected by the prevailing wind, retains its leading shoot until late in life when grown alone, and has no great tendency to develop large side branches near the ground. Such a species is not easy to find. Sycamore and ash stand wind well, and are not characterised by low side branches, but they are both apt to lose their leading shoot early in life and develop a short bole. Wych elm quickly loses its leading shoot, and forms a low spreading crown, and the same happens to the oak, except on a first-class oak soil, and there attention should be chiefly directed to this tree for hedgerow planting. Care should be taken to use only the sessile-flowered species, the branches of which are much less spreading than is the case with the pedunculate oak. The beech speedily kills any hedge plants over which it casts its shade, so that its use, in this connection, is practically excluded.

The English elm is probably the tree best suited for hedgerow planting over wide stretches in the Midlands and South of England. The value of the timber is not high, but taking into consideration its tall, straight, and well-shaped bole, its comparatively small crown, and the rapidity of its growth, one is certainly justified in regarding this tree as worth its standing room. An additional feature of value connected with the English elm consists in the fact that it propagates itself readily from suckers, so that a continuous succession of saplings is always coming on to take the place of felled or blown timber.

As regards soil, the same principle applies in a general way to this tree as to any other species, and poor soils are not likely to bring about satisfactory results, either in landscape effect or commercial timber. In the South of England, however, there are few soils which are not sufficiently deep and good to produce timber of fair size, though neither poor, hard gravels, nor stiff, wet clays are conducive to a rapid growth. Some of the best English elm timber is grown on the edge of the chalk districts, and in the

valleys which intersect the Downs. In most districts, however, at low or moderate elevations, trees containing 300 cubic ft. of timber are frequently met with, though butts averaging 80 ft. or 100 ft. make as good a price as any. The black Italian and silver poplars possess a high-pitched crown, and are thus well adapted to grow in a hedge. The lime and Spanish chestnut, on the other hand, cast too much shade to be altogether suitable.

Establishment.

Though much of the existing hedgerow timber may be considered as having originated spontaneously, and in the case of English elm or other sucker-producing trees may require no special measures for its reproduction, the establishment of hedgerow trees on fresh ground, or in a new hedge, can only be accomplished by planting. This should be done, if possible, at the time the hedge is planted, as smaller and less expensive plants can then be used. But where it is desired to plant in an old, or established hedge, stout well-rooted trees from 6–8 ft. high should be planted about 20 to 30 ft. apart, setting them securely in the centre of the hedge by cutting a trench through the latter, and filling in with some good fresh soil. Such trees must be protected from cattle and horses for a few years, and this is more easily done when the hedge is allowed to grow untrimmed for a time, so that those animals are prevented from reaching the stems of the trees by the long shoots of the hedge.

To obtain a park-like effect, arranging the trees both singly and in groups of twos or threes is a good plan, and by thinning out later on, modifications of the original idea can be brought about if desired. It is also as well to plant fairly thickly at the outset, as it is unlikely that every tree will develop into a good specimen, even when the most careful pruning is carried out.

Management.

The subsequent management will chiefly consist in the selection or retention of suitable trees or saplings and the removal of low side branches or double leaders at an early age. In selecting the saplings at each cutting or laying of the hedge only those with straight stems and well-defined leading shoots should be considered, all others being taken out whenever the opportunity occurs. Trees with crooked stems or of stunted growth, as well as any inclined to be flat-topped early in life, should be removed as soon as they exhibit these features, or at the first periodic fall of timber which takes place, and only the best type of tree encouraged or allowed to grow to maturity. As soon as individual trees have reached a height of 30 ft. or so the

pruning off of low side branches should begin, and be continued periodically until good boles are obtained, while all wide-spreading branches should be shortened back. How much of the stem may be denuded of branches will depend on species, age, and soil, but generally speaking the clear bole may be one-third to one-fourth of the height of the tree. The branches removed from the bole should be sawn or cut off neatly close to the main stem, and if more than 3 in. in diameter should be dressed with coal tar. If pruned early enough, the pole-saw or pruning chisel will usually do all that is necessary, and at little expense. Neglected until the branches are large, however, pruning becomes a costly operation and one tending to blemish the timber. Judicious pruning both improves the quality of the timber and allows sufficient light to reach the ground below to enable an ordinary hedge to be maintained in health and vigour. A good deal, however, depends on the soil and climate, a hedge being able to stand more shade where the soil and climate are good than under other circumstances.

The chief point about the treatment of hedges under trees is the method of cutting. It will usually be found that when they are either allowed to grow rough for four or five years, and then cut hard back, or when cut and laid periodically, the hedges are maintained in better health and are more capable of resisting stock than when cut or trimmed annually. Annual cutting also prevents tillers and suckers from getting away, as they cannot readily be distinguished from hedge shoots, and are usually cut off. But cut as suggested above, both hedge and suckers have an equal chance, and one is not favoured at the expense of the other. Cutting the timber before it attains too great a size or age also aids in preserving the vigour of a hedge. From 80—120 years is quite old enough for elm timber when grown at a normal rate, and at that age it has not overshadowed a hedge long enough to affect its constitutional vitality, provided it has been treated on rational lines.

A word of caution must be uttered with regard to driving nails into or fixing wire to trees. It is a slovenly and objectionable practice, and greatly diminishes the value of the timber.

4, Whitehall Place, London, S.W.,
November, 1905.

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Leaflet No. 157.

BOARD OF AGRICULTURE AND FISHERIES.

The Sale of Newly-Hatched Chickens.

The sale of newly-hatched chickens, or, as they are frequently termed, "day-old" chickens, is a branch of the poultry industry which is now of some importance. Ten years ago it was almost unknown in this country, but the introduction of incubators and brooders has made it possible to meet in this way the demand for chickens on the part of farmers and others. The first consideration is the number of incubators required, and these involve considerable expenditure.

Obtaining the Eggs.

A regular supply of fertile eggs will be necessary from January to June in order to keep the incubators filled, which requires a flock of fowls or an organisation for the securing of supplies. For a plant with a capacity equal to the production of, say, 1,000 chickens per week from February to June, or twenty weeks in all, at least 30,000 eggs will be required. Assuming an average of sixty eggs produced by each hen during that time, 600 head of stock would be needed to meet the demand. The prime necessity is that the breeding stock shall be at liberty and not kept in confined areas, as eggs from hens highly bred, highly fed, or kept in confinement, are found not to hatch so well artificially as those produced from breeding stock treated in a more natural manner, while the chickens produced from such eggs are less vigorous and do not travel well. The question of free range for the stock may, indeed, be regarded as essential, as it is most important that the chickens shall have a considerable reserve of natural vigour.

Pure or Cross-Bred Birds.

For the attainment of success it is necessary to be able to supply chickens of the breeds required by purchasers, and the demand varies in different districts. Eggs from cross-bred birds hatch out a larger percentage, and the chickens

are hardier and travel better than pure-breds, but the prices obtained for crosses are never so high as those for pure-bred chickens, while the cost in each case is the same. For these reasons the trade is chiefly in definite breeds. Where operations are upon a small scale one breed only need be kept, provided an adequate demand can be secured. But in large establishments several breeds must be maintained, and these of the classes most saleable. Chicks of the heavier breeds are believed to stand travelling better than those of the lighter varieties.

Cost of Hatching and Prices obtained.

Experiments conducted upon the Reading College Poultry Farm, Theale, during 1904 and 1905, showed that, assuming the cost per egg to be one penny, and allowing for 30 per cent. of fertile eggs not hatching, but without charging anything for interest upon capital or for labour, the actual expense of producing a chicken was approximately $1\frac{3}{4}d.$ Putting interest and labour at the same figure, though this would be increased or decreased according to the extent of the operations, the prime cost may be reckoned at 3*s.* 6*d.* per dozen. To that must be added the expense of a suitable box for packing the birds and of conveyance to the nearest station.

Prices vary considerably in accordance with the time of year and the class of fowls. Chickens, for instance, which are intended to be used as breeding stock command higher rates than those intended for killing or for farmyard purposes. But there is at present very little demand except for birds which are intended to be raised as breeding or laying stock. The fashionable varieties are always in demand to a greater extent, and sell at higher rates than utility breeds.

The trade in selling day-old chicks to farmers is as yet in its infancy, as they have not fully realised the advantages of obtaining fresh stock in this way.

When to Despatch.

The best age at which to despatch the chickens is when they are twenty-four hours old, or as soon as they have dried off and overcome the strain of hatching. If sent away too early they would feel the change and be liable to take a chill, which would be fatal. The experience obtained at the College Poultry Farm has been that when chicks are hatched either by the hen or by the machine, it is better to leave them in the place of hatching for twenty-four to thirty hours before removal to coop or brooder, and the same is largely true when they are to be sent away. But it must not be too long delayed, for when once they begin to eat the supply of food must be regular. Chicks two days old do not travel so well as twenty-four hours before, and with every

additional day they are more liable to feel the effects of transportation. When sent off at the right age, in suitable boxes, they will travel long distances by land or sea quite safely, even when the journey occupies as much as thirty-six hours.

Packing and Despatching.

The best packages are light wooden boxes, with several ventilating holes near the top of the sides and in the lid, and fitted with a handle made of thick cord, or tied round with thick string. For a dozen chickens a box about 14 in. by 9 in. and 9 in. high is large enough; for two dozen, 15 in. square. The floor should be thickly covered with cut chaff, among which may be scattered some coarse oatmeal, *dari*, and canary seed, and the sides, more especially the corners, lined with soft hay. The lid is better if lined with coarse flannel tacked at the edges, but loose enough to hang down in the centre. If the journey is to be a long one, a lettuce or two may be hung where the chicks can reach it. The box should be well made, and tied down, not nailed. There is much greater risk during very severe weather, more especially in cross-country journeys, when there is danger of exposure at open stations, and care should be taken to despatch the chicks by fast trains making good connections, and if possible at night. But the sale of these birds is generally in the milder spring months, when the risk is not so great as it would be earlier in the season. Boxes should be prominently labelled "Live chickens—this side up."

Treatment at Destination.

Not the least important point is the treatment of the chickens on arrival at their destination. Unless that is favourable, all the efforts of the vendor may be lost. It is to his interest to satisfy his customers by sending them hardy birds, but he has no means of controlling them when once they have left his charge, and the responsibility rests with the purchaser. There is nothing better than placing the youngsters for an hour or two in a brooder heated to as near 100 degs. F. as possible, and in the absence of such an appliance, excellent results have been obtained by putting them, in a flannel-lined basket, into an oven (leaving the door open) at a temperature not higher than that named; or it will be enough if the basket is placed near the kitchen fire. They should then be given a good feed of warm steeped oatmeal or biscuit meal, and have a little warm milk to drink. If broody hens are available, the best results will be obtained by rearing the chickens under them, if they have travelled a considerable distance. One or two only should be given to a hen at first and if she takes kindly to these the

remainder may be slipped under her wings. Where rearers are to be employed (and small, inexpensive appliances are now sold), these must be well warmed up, say to 95 degrees F., and the chicks placed therein. Around or in these brooders, according to the class, cut chaff should be littered, and among it scattered what is known as the dry feed. In an hour or two the chicks will begin to scratch and seek for food.

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Leaflet No. 158.

BOARD OF AGRICULTURE AND FISHERIES.

White Rot of the Vine
(*Coniothyrium diplodiella*, Sacc.).

Grapes and Branch attacked by "White Rot."

This disease is due to the presence of a minute parasitic fungus. On the Continent and in the United States it attacks vines growing in the open air, and during recent years has frequently been met with on vines growing under glass in this country.

Parts of the Vine attacked.

The fruit is the part most frequently attacked. and in severe cases the fungus spreads from the stalk of the bunch of fruit to the branch from which it springs. The foliage is never attacked. When once established, the disease spreads rapidly, and usually every grape on a bunch becomes

diseased, owing to the numerous minute spores of the fungus being conveyed by rain, syringing, &c., from diseased to healthy berries.

Appearance of Infested Parts.

During the first stage of disease the berries become pale brown in colour, and soon commence to shrivel, but do not fall. At a later stage, when the shrivelled berries have become dry, the skin assumes a dull, silvery appearance, and is covered with minute white pimples forming the fruit of the fungus.

When the stalk of a diseased bunch is attacked, the fungus often extends to the supporting branch, where it forms slightly depressed areas, which are at first brownish in colour, but eventually become studded with the characteristic whitish pustules of the fungous fruit. The diseased patches may extend for several inches down one side, or the branch may be completely girdled by an irregular zone of diseased tissue, and, if this is the case, that portion of the branch above the injured zone soon dies. In vineyards the disease is most injurious during seasons of great humidity accompanied by warmth. Under such conditions one-quarter to one-third of the crop may be destroyed within the space of a few hours.

Remedies.

1.—The best remedy is to remove and burn all diseased bunches of fruit, and spray every part thoroughly once every five days with a rose-red solution of permanganate of potash. If the disease is of recent origin and confined to the bunches of fruit, the above treatment will suffice.

2.—If the disease has spread to the branches, its presence will be indicated by the slightly depressed, pale-coloured patches on the bark already mentioned. All such diseased branches should be cut out, as spraying will not check the disease on permanent parts of the vine, where the mycelium of the fungus spreads rapidly in the tissues.

3.—Where the disease has existed, every part of the vines, and the soil, walls, glass, &c., should be thoroughly drenched with a solution consisting of one pound of sulphate of copper dissolved in twenty-five gallons of water. This dressing should be applied during the winter before the leaf-buds begin to swell, otherwise the foliage will be destroyed.

4, Whitehall Place, London, S.W.
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Leaflet No. 159.

BOARD OF AGRICULTURE AND FISHERIES.

Blindness in Barley and Oats.

Since 1897 attention has been drawn in Great Britain to a disease of the barley crop known as "blindness" or barley "stripe."

Plants attacked.

Fifty years ago, Rabenhorst, a German botanist, issued specimens of a minute fungus under the name of *Helminthosporium gramineum*, parasitic on the leaves of cultivated barley in Germany. It was noted that plants attacked by the fungus died during the flowering period.

The fungus has subsequently been recorded from other European countries as a parasite on barley, and has in many cases caused serious losses. It does not, however, appear in any instance to have assumed the proportions of an extended epidemic, but has been local and sporadic in its occurrence. During recent years the disease has become common in this country, and in some districts it is now difficult to find a barley field free from it. It is not unusual to find some twenty per cent. of the plants killed by the attacks of this fungus.

The fungus has also been observed on the leaves of wild barley (*Hordeum murinum*) in the neighbourhood of Kew.

Ravn, a Danish botanist, has recently studied the disease, and has shown that oats are subject to a similar disease, caused by a fungus very closely allied to the *Helminthosporium* of barley.

Appearance of attacked Crop.

The symptoms are characteristic and not likely to be confused with those of other disease to which the barley crop is liable. The foliage of the diseased plant, even in the seedling stage, is marked with olive-brown or purple-brown stripes and flecks. The infected plant may wither and die at this stage, but more often it appears that death does not take place until the flowering stage is reached. Then, just as the ears are pushing through the sheaths, the plant turns brown and dies off completely. Unaffected plants quickly grow above those which have become infected and consequently the presence of the disease is not readily detected unless a special search is made for it. Whilst the crop is being thrashed the blind ears of diseased plants are conspicuous amongst the straw, and often give the first indication of the losses the parasite has caused.

Methods of Prevention.

1.—The fungus is not difficult to deal with in practice. The evidence points to the fact that the death of the plant is due to infection at a very early stage of its development with spores of the fungus lurking on the grain coats. The application of any method which will destroy such spores should naturally result in a disease-free crop. Working on this assumption numbers of preventive measures have been tried, and among these may be mentioned steeping the grain before sowing either (1) in a solution of copper sulphate, or (2) in dilute formalin, or (3) in water at a temperature of 132 deg. F.

2.—Each of the foregoing methods has proved more or less satisfactory, but the best results have been secured by the use of dilute formalin. The most effective method of employing this is to make up a solution of one part of formalin in 160 of water (1 pint of the formalin in 20 gallons of water). The grain should be placed in a sack or wicker basket and steeped in the formalin solution for about five minutes, care being taken to moisten it thoroughly by lifting the sack or basket from time to time and twisting it about in the solution. Further quantities of grain may be treated with the same solution. In place of steeping in a basket a heap of grain may be sprinkled with the dilute formalin and turned repeatedly to distribute the solution thoroughly.

The cost per bushel of seed grain treated is very small, formalin costing 1*s.* 6*d.* to 2*s.* per pint, this amount, in 20 gallons of water, being sufficient for steeping about 30 bushels of seed. As the method also destroys the spores of barley smut it can be relied upon to pay for itself. In a series of experiments recently carried out the application of formalin resulted in an increase of over twenty per cent. in the crop.

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Leaflet No. 160.

BOARD OF AGRICULTURE AND FISHERIES.

The Cultivation of Lucerne (*Medicago sativa*).

Lucerne has not hitherto been appreciated or used in England to the extent that it has been on the Continent, and in the United States and Argentina, where it is known as Alfalfa.

English farmers, however, are now more fully realising its value as a fodder crop, especially in districts which are liable to drought, and on warm calcareous soils. It is not to be expected, however, that in this country the crop will attain such an extensive cultivation or the degree of popularity which it has secured in warmer climates. Compared with that of southern Continental districts, in which lucerne is largely grown, our climate is moist and cool, and is more suited to the growth of grass, vetches, and other fodder crops. Lucerne is a highly nutritious and palatable food for all kinds of farm stock; being rich in protein, however, it should be combined with some other food rich in carbohydrates—*e.g.*, barley or maize.

Soil and Climate.

The crop is essentially one for dry climates and dry soils, and in such positions it is invaluable. Although a calcareous soil is not essential for its successful growth, the crop thrives better where there is plenty of lime, either in the soil or the sub-soil. Where such a favourable condition exists, the long, strong roots, which render a crop of lucerne practically independent of rain, often penetrate to a depth of many feet. Strong soils inclined to be wet are not suitable for the growth of lucerne. The duration of the crop varies somewhat, but in this country under favourable conditions it will usually continue to yield a large bulk of produce during a period of from five to eight years.

Preparing the Seed-bed.

Satisfactory results can be secured only when the seed is sown on thoroughly clean land. Where lucerne is sown alone this is of vital importance, for if the land is at all foul, innumerable weeds come up with the young plant and choke it. In preparation for sowing it is generally advisable to

get the land in clean condition by the growth of a fallow crop, which should be heavily manured and carefully cleaned. Farmyard manure should not be applied directly to lucerne, for the reason that it encourages the growth of weeds to a relatively greater extent than it benefits the crop in question. Three or four hundredweight of superphosphate and one hundredweight of sulphate of potash, or an equivalent quantity of other phosphatic and potassic manures, form a suitable dressing per acre. On land where lime is deficient a dressing of this substance will prove beneficial. A fine seed-bed should be obtained as in the case of clovers.

Seed and Method of Sowing.

French seed is preferable to American, as plants grown from the former usually prove hardier during a severe winter. Experience has shown also that on land sown down for long periods, French seed will give better crops than American. Great care should be taken to obtain good, sound seed, free from dodder and other weed seeds.

The seed may be sown either alone or with a corn crop. In this country the former method is, perhaps, the one more generally adopted, but some growers consider it more advisable to sow the seed in a grain crop, such as barley. In a dry spring and summer the "nurse" crop affords protection to the lucerne during its young and tender stage. The best time for sowing, when the seed is sown without a corn crop, is between the middle of April and the end of May. From 15 to 30 lb. of seed is sown per acre, the quantity being least where the land is in fine tilth and clean, and less when drilled than when broadcast. If the land is thoroughly clean broadcasting is to be preferred to drilling, for by this means the surface of the ground is more quickly covered with the crop, and the establishment of weeds is more effectively excluded. Drilling 6 to 8 inches apart, on the other hand, may be practised on land that is hardly so clean as is desirable, but the system offers no advantages unless hoeing between the rows can be attended to during the first year.

In a series of experiments carried out by the University College, Reading, good results were obtained on the lighter class of soils, by including a few pounds of lucerne seed with the grass and clover seeds sown for a two or three years' ley, and this practice may be recommended to the notice of farmers who have to deal with hot, dry land.

Cutting the Crop.

Lucerne is not well adapted for grazing, being generally cut for hay or "soiling" just before coming into flower. It does not attain its full productiveness in its first

year, but should yield one cutting, and possibly a second, by the autumn following sowing. In subsequent years it may produce upwards of 20 tons of green fodder, or $2\frac{1}{2}$ to 4 tons of hay. If made into hay the leaves are liable to be lost in the drying and handling of the crop, which should therefore be harvested with great care. The most satisfactory method of utilizing the crop, however, is to give it to stock in a green state. It yields a large bulk of produce which for this purpose is invaluable. It is also an excellent crop for utilization as ensilage, and if the silo is filled with a mixture of equal parts of lucerne and green maize a most valuable food for all kinds of stock is produced.

4, Whitehall Place, London, S.W.
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BOARD OF AGRICULTURE AND FISHERIES.

The Vapourer Moth (*Orgyia antiqua*).

Caterpillar on Leaf ; winged male, top right-hand corner ; and female moth on cocoon, surrounded by eggs.

The caterpillars of this moth are harmful to forest trees, fruit trees, garden plants, and even to pot plants, and in some seasons are very destructive. The food plants are very numerous, and embrace pear, plum, apricot, sloe, hawthorn, apple, strawberry, mountain ash, roses, bilberry, laurel, mahonia, elm, willow, poplar, birch, alder, hazel, hornbeam, beech, oak, ash, lime, while there are records of severe infestation on pine and spruce. The caterpillars may be found from May to September, and the adult moths may be taken any time from the end of June up to and including September. The Vapourer Moth is found in Europe, N. Africa, and Western Asia. In Europe and over Britain and Ireland it is common, and is to be found in towns as well as in the country.

Description of the Insect.

Moth.—There is a marked difference between the male and female moths. The *male* measures from 1 inch to $1\frac{1}{4}$ inch in expanse of wings. The body is brown: the wings are ochreous or chestnut brown, the fore-wings having dark markings. Near the hind angle of each fore-wing is a somewhat crescent-shaped clear white spot. The antennæ are double-combed. The *female* is yellow-grey in colour, hairy, and unable to fly, the wings being reduced to mere stumps. The antennæ are saw-like or single combed.

Egg.—The eggs are whitish-grey in colour and are laid in great numbers. Examined with a lens they are seen to be round, but somewhat flattened on the upper side.

Caterpillar.—The 16-footed caterpillar presents a very gay appearance. It is very hairy, long light-coloured hairs springing from reddish warts all down each side of the body. Tufts of yellow or brownish hairs are very conspicuous on the back on segments 5, 6, 7, and 8, two tufts to each segment. Conspicuous also are two dark-coloured tufts springing from behind the head and pointing over it; similar tufts project one from each side of segment 5, and also a long slender one at the tail end. The under side of the caterpillar is yellowish. The full grown caterpillar measures up to 2 inches.

Pupa.—The chrysalis is yellowish and lies under cover of a somewhat oval-shaped yellow-grey web or cocoon. Mixed in the web are the hairs of the caterpillar.

Life History.

The male moths are active fliers, but the females are very sluggish. On issuing from the cocoon the female settles on the outside of the cocoon, and after pairing lays, on and all round the cocoon, eggs up to 300 and over. Some of these eggs hatch in a fortnight to three weeks, others taking longer, while some from the same laying may not give out their caterpillars until the next year in late spring. This means that all stages of the insect from egg to adult may be met with at the same time. The young caterpillars soon after hatching scatter over the tree. When the caterpillars are full fed they spin their cocoons, these being attached to leaves or twigs, or crevices in the bark. The pupation stage may be completed in three weeks. Two broods in the year are possible. If the eggs that have over-wintered hatch in the early part of May, pupation of the resulting caterpillars may take place in time for a second brood of moths by September. On the other hand there may be only one generation in the

year—*i.e.*, moths developed in summer as a result of eggs laid in the previous year, and not hatching till after the winter, may go on to egg-laying in their turn, but these eggs may not hatch in the same year in which they are laid. The practical point, however, is that, owing to the overlapping of generations, caterpillars may be found all the season from May till September.

Preventive and Remedial Measures.

1.—The best way to fight the pest is to destroy the egg-masses with the cocoons, especially in winter.

2.—It should be remembered that as the females are wingless, attack may be expected to repeat itself in the same locality and with an increased number of enemies.

3.—Where the caterpillars have got to work they should be shaken off the plants and destroyed.

4.—Spraying the plant, where practicable, with Paris Green, in the proportion of 1 lb. of Paris Green to 200 gallons of water, would poison the food of the caterpillars.

4, Whitehall Place, London, S.W.,
May, 1906.

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Leaflet No. 162.

BOARD OF AGRICULTURE AND FISHERIES.

Grafting Fruit Trees.

Grafting or budding, though requiring some skill, is not a difficult art to learn. The best way is to obtain some practical instruction, and then, before attempting anything with growing stocks, to practise the various cuts and fittings with pieces of wood of different sizes.

To attain success in grafting the worker must employ stocks which are in just the right condition, *i.e.*, with the sap flowing freely, the grafts nicely fresh and not shrivelled, and all cuts made cleanly and fitting together exactly. It can be easily ascertained if the sap is right in the stock by cutting off the latter some little distance above the point where the graft is to be placed, making a slit in the bark and observing if it parts freely from the wood. If it will not part freely the grafts would not be likely to "take" and the operation must be postponed. To ensure the grafts being fresh they should be left on the trees until there is a possibility of the buds beginning to burst. After cutting, they may be neatly tied in bundles with the ends level, carefully labelled, with the name showing, and stood in deepish drills in a shaded border, with the soil made firm round the ends. They may also be kept fresh for some time by standing them in a couple of inches of water in a dish in a cool room. To make the cuts clean a very sharp knife must be used, and the smoother the cuts are made the more quickly they heal.

The time for grafting various fruits depends very much on the earliness or otherwise of the season. With stone fruits a commencement can sometimes be made in late March and early April, pears being begun about the same time, and apples from the middle of April till the second week in May.

Preparation and Planting of Stocks.

It is generally better to purchase stocks from firms who make a speciality of them and supply the trade, than to attempt to raise them. They are very cheap—not more than thirty-five shillings per thousand if bought in quantity. If only a few dozens or scores are wanted, it is as well to obtain them from the nearest reliable nurseryman. The soil for stocks should be trenched, either by turning both soil and subsoil upside down, or by bastard trenching, when the subsoil is kept below and the soil on top. No manure should be applied where it would be under the roots, as it encourages downward rooting. The soil should be ready by the time the stocks can be obtained in early winter. When received, it is well to sort the stocks according to size,

trim the roots, and shorten the heads to about two feet in length. They may then be placed with the roots in soil, to keep fresh till they can be planted.

Stocks should be planted in rows three feet apart, and one foot apart in the rows, at the same depth as they had been previously. The roots may be covered with a little soil and then manure applied to encourage lateral and surface rooting. After treading very firmly, keeping the lines quite straight, the soil may be lightly forked over just to loosen the surface. When sorting over, all stocks should be carefully examined for American blight, and, if any is found, dressed accordingly. (*See* Leaflet No. 34.) In the summer, they must be examined for aphides, and, if any are found, sprayed with a soft soap wash. (*See* Leaflet No. 104.)

If the stocks do well, they should be ready for budding in August and September following, or grafting in the spring of the next year. The smaller ones may need another year's growth.

Kinds of Stocks.

For *apples* to be grown as standards, half-standards, or espaliers, the seedling apple and seedling crab are to be recommended, and for dwarf or bush trees, the English Paradise stock; for *pears*, the seedling pear and quince respectively. *Plums* are budded and grafted on the seedling plum and Myrobalan plum; they do well on the latter in the lias clays of Somerset, where the Myrobalan or "Cherry" plum fruits very freely. The Myrobalan also suits the *apricot* in those soils, and it is also worked on the Mussels and Brussels plums. For *cherries*, the Mahaleb and wild cherry are used, while for *peaches* and *nectarines*, the almond and plum are employed. A batch of stocks can readily be raised by taking up suckers from various trees, but it is a bad practice, as they are prone to future suckering.

All stone fruits do better when budded than when grafted, there being a truer junction between bud and stock than obtains with grafts.

Methods of Grafting.

Whip or Tongue Grafting.—This method (Fig. 1) is chiefly employed in the case of stocks of about half an inch in diameter. The graft is prepared by taking off a slice on one side about $1\frac{1}{2}$ to 2 in. long, the upper end of the cut being opposite a bud, and the lower end cut away to nothing. The stock should have been cut off about 4 to 6 in. from the soil. Place the graft against the stock to measure how long to make the cut on the latter, then shave off a slice of bark and wood just a little wider than the cut on the graft. This is necessary in order to make the two *inner* barks of graft and stock fit together, and the bark of the former would be thinner than that of the latter. It is between these two

inner barks that the union or junction is formed. The tongues in both must then be fitted together as shown and tied securely with bast or raffia and waxed over. Sometimes another small tongue is made in the stock at the bottom of the cut and the end of the graft tucked under it, as shown in Fig. 1, E, *n*.

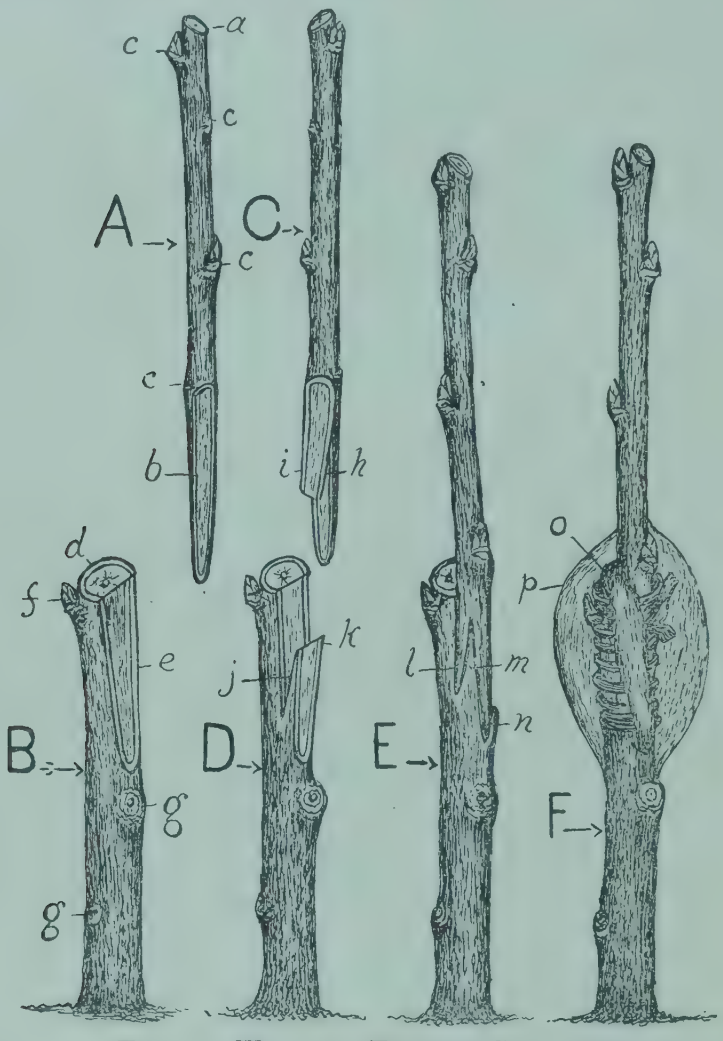


FIG. 1.—WHIP OR TONGUE GRAFTING.

A, scion or graft partly prepared : *a*, upper end cut sloping from a bud ; *b*, lower end sliced ; *c*, position of buds. B, stock partly prepared : *d*, point of severing top of stock ; *e*, sliced for fitting of graft ; *f*, bud left (if present) to attract sap ; *g*, points where growths removed. C, graft tongued : *h*, opening ; *i*, tongue. D, stock tongued : *j*, opening ; *k*, tongue. E, graft fitted properly on stock : *l*, tongue of graft ; *m*, tongue of stock ; *n*, small tongue (sometimes made and end of graft inserted in it). F, graft and stock tied and *o*, waxed ; or *p*, clayed.

Saddle Grafting.—There are various methods of saddle grafting. The first (Fig. 2) may be used in grafting stocks about three-quarters of an inch in diameter. This stock is made to an acute wedge shape by cutting off a slice on each side. Another (downward) cut on each side is made through the bark and a thin slice of the wood. The graft is cut saddle-shaped as shown by making a cut on each side of the

same length—about $1\frac{1}{2}$ to 2 in. Both cuts are rather thin till they reach the upper end opposite to a bud, when the knife is slipped in, and, when the second cut is made, the piece of wood drops out. The graft may now be placed in position across the wedged end of the stock, allowing the ends to go underneath the bark; then tied in and waxed. Grafts made in this way take very well and soon grow over the stocks.

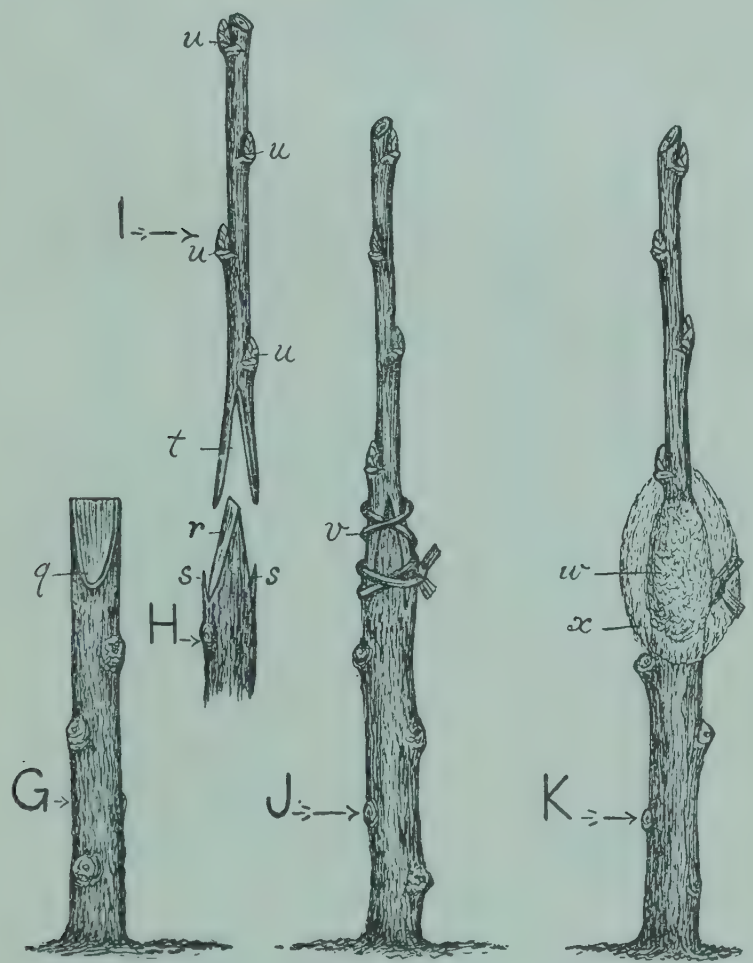


FIG. 2.—SADDLE GRAFTING.

G, stock sliced on one side to be repeated on corresponding opposite side: *q*, point of making downward cut. H, top of stock properly prepared: *r*, wedge-like form; *s*, tongues or downward cuts. I, scion or graft prepared for placing on stock: *t*, saddle-shape of lower part made by two cuts; *u*, buds. J, graft properly placed on stock, the two inner barks coinciding, at least on one side of stock: *v*, ligature securing graft to stock. K, junction of stock and graft cuts or wounds: *w*, waxed: *x*, clayed, not both.

Another method is what may be termed the "Somerset" saddle (Fig. 3), as it is more practised in that county than any other. It is a better and stronger method than the last, and can be used on stocks up to an inch in thickness. Sometimes it is employed for even larger ones up to two inches thick, in which case two are put in on opposite sides.

the end of the stock being cut square instead of on the slant. In either case, making the cuts in the graft is an operation needing a good deal of skill and practice. In the method under notice the stock is prepared by a longish cut on one side only. A slit is then made in the bark on each side in just the same way as for bark or rind grafting (see below).

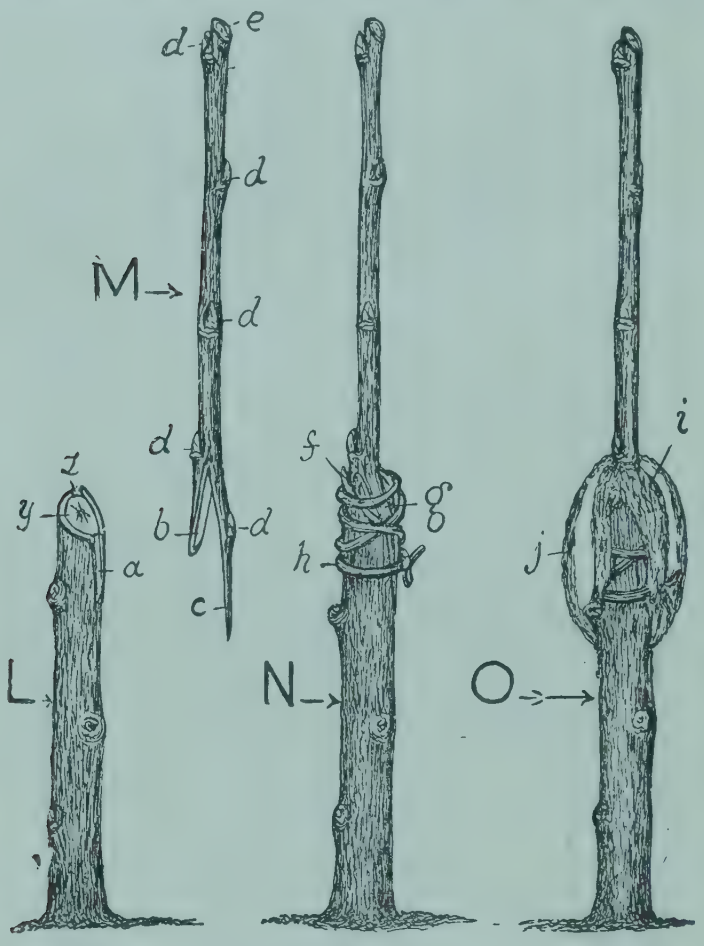


FIG. 3.—"SOMERSET" SADDLE GRAFTING.

L, stock prepared for graft: *y*, longish or slanting cut top when stem severed at proper height; *z*, slit made vertically in bark at highest point of slanting cut; *a*, slit made at lowest point of cut. M, scion or graft: *b*, short cut side of saddle; *c*, long or "strap" side of saddle; *d*, buds; *e*, top cut slanting on opposite side of bud. N, graft affixed on stock: *f*, short cut side of graft inserted under bark in slit; *g*, "strap" or long side of graft across cut of stock and under the bark on the lower side; *h*, ligature. O, junction of stock and scion wounds: *i*, waxed; *j*, clayed—one of these, not both.

If the sap is "up" the bark should part easily from the wood on giving the knife a slight twist on each side of the cuts. The first cut in the graft would be about an inch long (Fig. 3) and rather thick, or about half way through when it reaches the upper end to a bud. The other cut, to form the "strap," is double the length and thinner to allow for bending. At the upper end, when nearly opposite the first one, this cut is turned in at a more acute angle, when the wood should drop

out. The short cut side is inserted under the bark on the top of the cut on the stock, the "strap" going across and under the bark on the lower side; after which the graft is tied and waxed. If the graft takes properly and the stock is not too wide, it soon grows over the cut, and in a few years completely covers it.

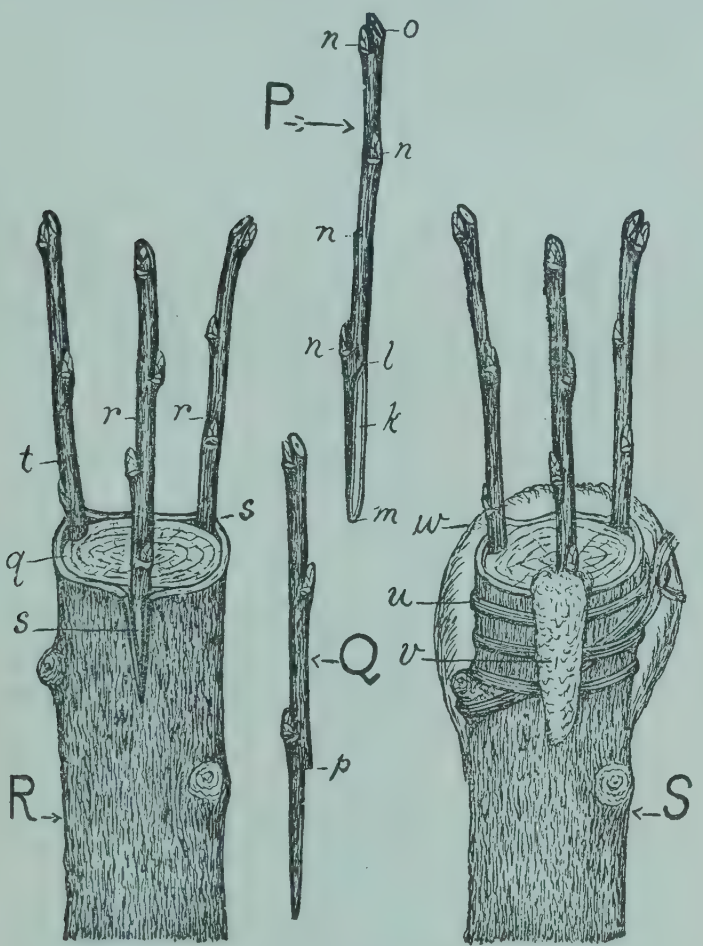


FIG. 4.—CROWN OR RIND GRAFTING.

P, scion or graft prepared by slicing: *k*, slice cut off one side opposite a bud at the upper end, *l*, and the bottom cut away to nothing, *m*; *n*, buds; *o*, top cut sloping from a bud. Q, graft prepared with a shoulder: *p*, point where cut made partly through, and with lower portion cut off to nothing forming shoulder to rest on top of stock. R, stock or limb: *q*, point where cut off; *r*, grafts with simple sliced off sides inserted in slits, *s*; *t*, graft with shoulder resting on top of stock. S, stock or limb after completing grafting: *u*, ligature; *v*, waxed over cuts or wounds, or, *w*, clayed over top of stock as well as slits.

In neither of these forms of saddle should the graft be split when preparing it, or when placed across the stock the split may extend and the graft become useless.

Crown or Rind Grafting.—This (Fig. 4) is the simplest method of all, and chiefly used on big branches of possibly oldish trees. The branches to be utilized as stocks should be sawn off some few weeks before grafting time, and a few

inches higher up than where they are to be grafted, being cut off again just before the grafts are put on. If the saw cut is pared over with a knife, the bark soon heals over. If the branch is growing upright a slightly sloping cut must be made to allow water to run off.

A slit is made through the bark, which is parted from the wood either by twisting the knife or, preferably, with a smooth flat piece of bone or hard wood about the size of

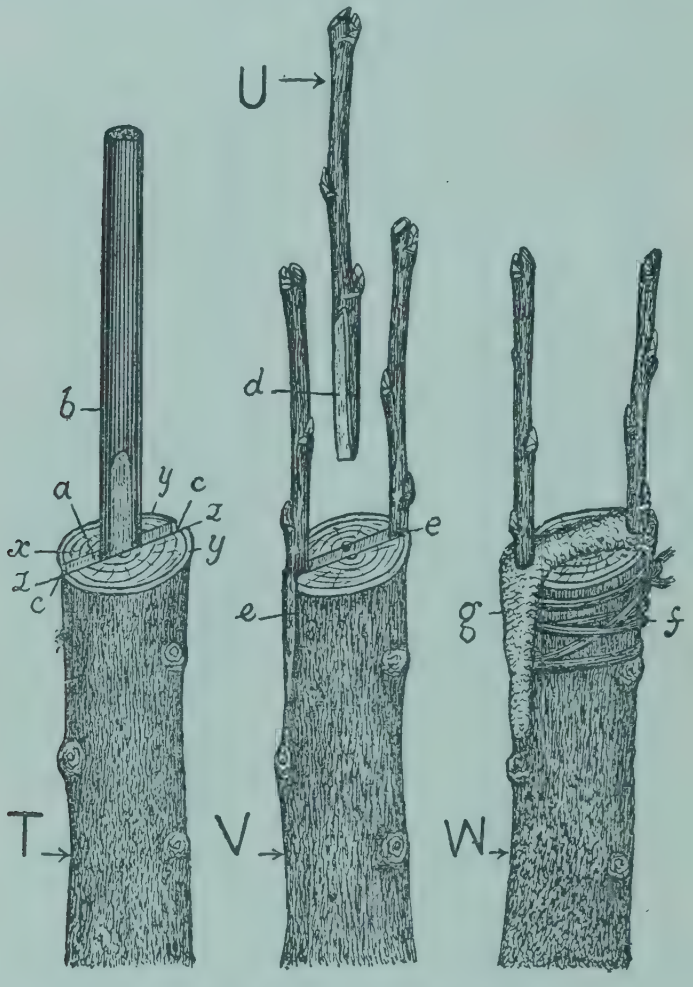


FIG. 5.—CLEFT OR WEDGE GRAFTING.

T, stem or branch prepared: *x*, point where cut and edges of bark pared smooth, *y*; *z*, point where split with hammer and chisel; *a*, cleft kept open by iron or wooden wedge, *b*; *c*, sides of cleft pared smooth and straight. U, scion or graft: *d*, lower end cut wedge-shaped. V, stem or branch with grafts properly inserted: *e*, inner barks entirely coinciding. W, operation completed: *f*, ligature; *g*, waxed over cleft and wounds.

the graft. A slice about two inches long is now cut off one side of the graft, the upper end of the cut being opposite a bud and the bottom cut away to nothing; the graft is then slid between the bark and the wood. By cutting off a thin bit of bark on each side of the slit, the bark will return to its place next the wood. Several grafts may be put on in this way, each one being cut so that the leading buds point

in opposite directions to grow away from each other. In all methods the grafts should be cut in such a way as to have a bud near the "collar" of the stock, which *bud*, when it grows, will assist in forming a strong union. After tying, just sufficient wax should be applied to cover and exclude air from the wounds or cuts.

Cleft or Wedge Grafting.—This is a very firm and sure method, but on rather large branches it is open to the objection that the moisture gathers in the cleft and decay commences in the wood. The branch is split with a hammer and chisel, the cleft being kept open with a wooden wedge. The sides of the cleft are pared smooth and straight, and the grafts cut wedge-shaped and inserted one on each side. The wooden wedge is removed, and the cleft, reducing in size, holds the grafts very firmly. Tying is hardly required, but it is safer to do it. Enough wax should be used to fill in and cover both cleft and wounds as before.

General.

Very soon after grafting time, the buds and young branches will begin growing from the stocks. They should be left for a time in order to encourage the sap to circulate, but when the grafts grow, be gradually reduced and finally removed altogether.

Both wax and clay are used to exclude air from the wounds. Wax has been recommended throughout, as it is in many ways preferable to clay. It is much cleaner to use, and can be more easily and quickly applied, while there is not the same shelter under it for American blight. A good wax for using warm or cold can be made with equal parts by weight of Burgundy pitch, kerosene wax, and tallow (melted candles will do), or, as tallow smells rather strongly while being melted, olive oil may be preferred. The materials should be melted together in an old saucepan, and if used warm the mixture can be put on with a paint brush, or if cold with a putty knife. At the cost of not more than eighteenpence, enough can be made for several hundreds of grafts.

Clay is cheaper, but cannot always be obtained ; it may be used in its natural state, according to the "temper" of the clay, or mixed with a third part of cow-dung. Cow-dung is also used alone, and also bands of hay and clay.

If the wax made as described is employed, it will remain fairly soft, and when the grafts grow well, about midsummer, if a slit is made in the raffia both will be pushed off by the swelling of the grafts.

4, Whitehall Place, London, S.W.,
April, 1906.
Revised, January, 1909.

19156 T 2

Leaflet No. 163.

BOARD OF AGRICULTURE AND FISHERIES.

White Rust of Cabbages (*Cystopus candidus*, Lév.).

White Rust—(1) on Shepherd's Purse; (2) on Young Cabbage Leaf.

This destructive fungus has a world-wide distribution, and attacks many kinds of plants belonging to the cabbage family — *Cruciferæ* — both cultivated and wild. In this country the various forms of cabbage radish, and horse-radish suffer most from its presence; among wild plants the Shepherd's purse is most frequently attacked (Fig. 1).

Description.

On the leaves the fungus forms snow-white polished blotches, which are often grouped in irregular concentric rings (Fig. 2). At maturity, these white patches break up into a powdery mass and the spores are scattered by wind and rain. Infection takes place only during the seedling stage of the host-plant. When the stem or flower is attacked much distortion and swelling is produced, and in the swollen parts numerous resting-spores are formed, which germinate and infect seedling-plants the following season.

Prevention and Remedy.

1.—Diseased leaves should be removed the moment the fungus is observed, but the most important point to attend to is the collection and burning of all swollen and contorted stems and flowers, as it is the spores present in these swollen parts that infect seedlings in the spring.

2.—Shepherd's purse should be eradicated, as this weed is, in the majority of instances, the host and primary source of infection of cultivated plants.

4, Whitehall Place, London, S.W.,
March, 1906.

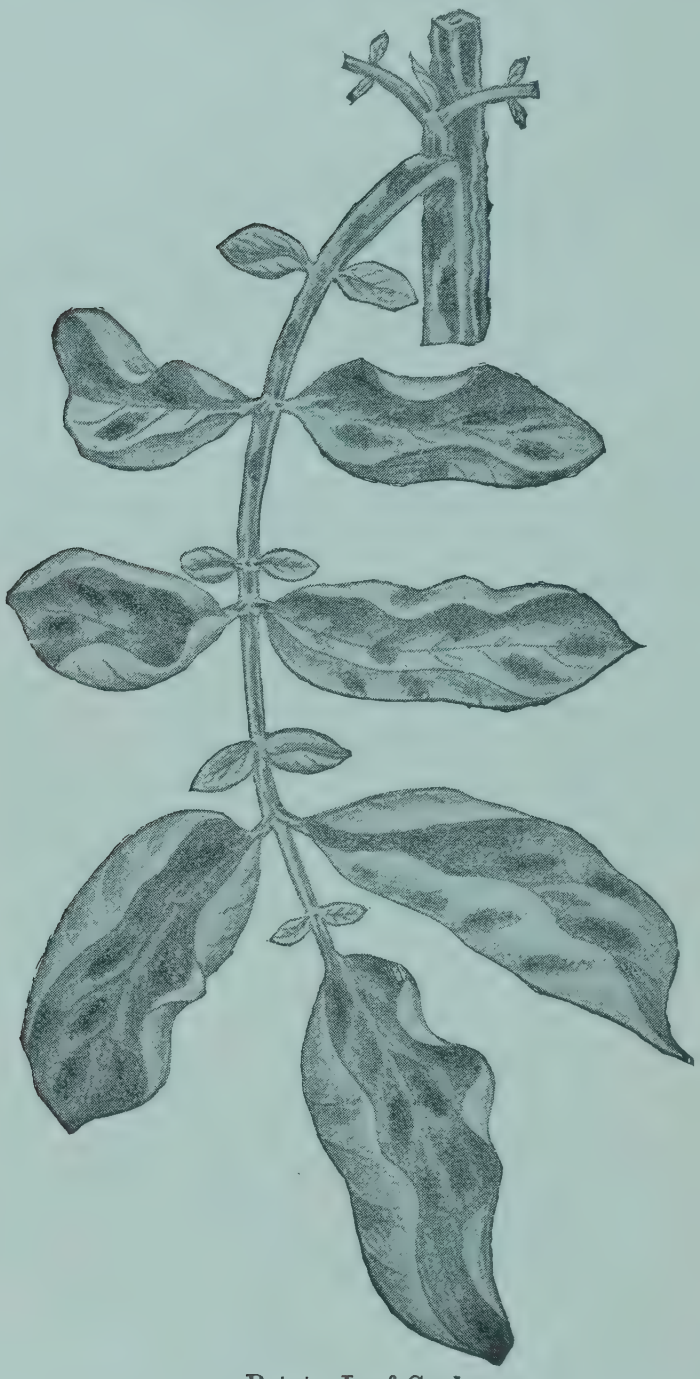
Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 20 leaflets dealing with Fungi injurious to Farm and Garden Crops may be obtained from the same address, price 1d. post free.

Leaflet No. 164.

BOARD OF AGRICULTURE AND FISHERIES.

Potato Leaf-Curl and Black-Stripe of Tomatoes (*Macrosporium solani*, Cke).



Potato Leaf-Curl.

This disease is widely diffused. In addition to Britain, it occurs on the Continent, and is rampant in the United States. It has also occurred on *Solanum Commersoni* grown at Kew.

Black-stripe of Tomatoes, was, until recently, considered to be caused by a fungus named *Macrosporium tomato*, Cke.

It has, however, recently been found that *M. tomato* is identical with *M. solani*, the difference in the appearance of the fungus on the two plants respectively being due partly to the host, but more especially to the fact that in the potato the fungus behaves as a perennial, its mycelium hybernating in the tubers, and growing along with the vegetative portion of the plant. In the tomato, however, there is no hybernating mycelium, and the fungus behaves as an annual, more especially infecting the fruit as a wound-parasite, but sometimes also infecting the stem and leaves. The disease, as manifested in the two plants, is dealt with separately for each.

Potato Leaf-Curl.

In the case of the potato the haulm is more or less stunted, the foliage is small and the leaflets are much curled. In many instances the shoots do not appear above-ground, leaving gaps in the rows. The haulm is infected either by hybernating mycelium passing directly from the tuber, or by means of spores present in the soil, which infect the young sprouts. In either case the arrest of growth and the curling of the leaves is due to the ascent of water and food being checked by the upward growth of the fungus mycelium in the tissues of the haulm. As the mycelium increases in quantity the haulm becomes limp and collapses, owing to lack of water.

If a tuber contains no hybernating mycelium the tubers it produces may become diseased, if the sprouts are infected while quite small, as the mycelium grows up along with the haulm, and passes into any tubers it may produce. Tubers which give origin to curled foliage do not decay, but remain firm and hard.

Experiments conducted at Kew show that when a tuber known to contain hybernating mycelium is planted, and the foliage shows the characteristic curl, the tubers produced by such an infected tuber do not perpetuate the disease *if they are lifted some time before they have completed their growth.* This suggests that the mycelium only passes from the haulm into the tubers during the last stages of growth, and further suggests that tubers intended for "seed" should be lifted before they have completed their growth. This, perhaps, explains the comparative freedom from leaf-curl of Scotch "seed," which, in the case of late or maincrop varieties, is invariably lifted in an immature condition.

It is also known that after having been grown for two or three years in the South of England, Scotch "seed" contracts leaf-curl, probably owing to the tubers being allowed to reach maturity before they are lifted, when they become infested with mycelium through infection of the sprouts as indicated above.

After the mycelium has passed up the haulm and into the

leaves, the fungus breaks through the tissues and produces its fruit in the form of numerous irregular, blackish, minutely velvety patches scattered over the surface of the haulm and leaves.

Preventive Measures.

1.—Under the circumstances, preventive measures will consist in not planting "sets" which were grown in an infected area; where the disease has occurred the haulms should be brought together and burned, otherwise the spores will infect the land.

2.—It is important that tubers intended for "sets" should be lifted before they reach maturity. This appears to be the most practical method of combating the disease.

3.—A dressing of kainit in the rows when the potatoes are planted would to a certain extent safeguard the crop, by killing spores present in the soil at the moment of germination.

4.—Spraying is of no avail.

Black-Stripe of Tomatoes.

This disease is sometimes known as Black Rot. The fruit is most frequently attacked, discoloured patches appearing, which become slightly sunken owing to collapse of the tissues. Such patches soon become covered with a delicate velvety pile of a blackish-olive colour. The fungus sometimes forms long, blackish stripes on the stem, and irregularly shaped blotches on the leaves.

Preventive Measures.

1.—Cleanliness, as usual, is of primary importance. If all diseased material is promptly burned no spores can exist to start an epidemic. Infection can only take place through a wound. Minute cracks on the fruit in the neighbourhood of the style, exposing the fruit to infection, are often the result of over-feeding, more especially when green stable manure is used.

2.—The fact must be kept in mind that the spores produced on the tomato plant may infect a potato plant, and *vice versâ*.

4, Whitehall Place, London, S.W.
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Revised, July, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

GALL-GNATS INJURIOUS TO WILLOWS AND OSIERS.

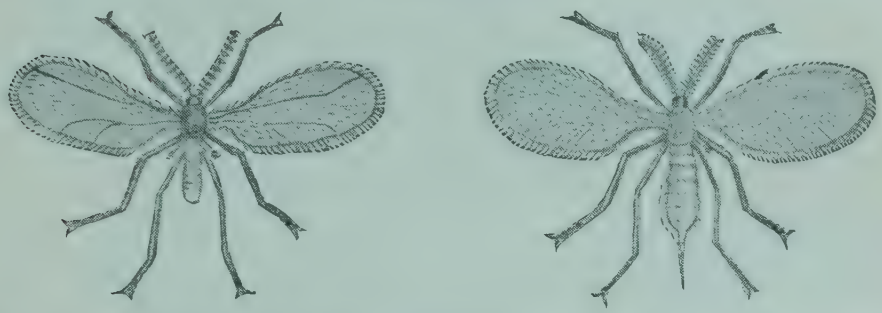


FIG. 1.—*Cecidomyia saliciperda* (magnified). Male to left, female to right. After Nitsche.

The Gall-Gnat Family, or *Cecidomyidæ*, is a family of two-winged or dipterous insects. These flies are tiny, delicate in structure, and with few nervures to the wings; their somewhat long antennæ have, typically, whorls of fine hairs at the joints; the legs are long and slender; the wings and body bear hairs which are easily rubbed off. The larvæ are small maggots, and on the lower surface of the front end of the body some have a so-called anchor-plate, or "breast bone," which may be used for leaping, for changing position, or perhaps in feeding.

The food habits of the larvæ vary considerably, but all the willow-infesting species are found in characteristic galls or malformations, the galls being on young or older twigs, at the apices of twigs, on flower buds, or on leaves.

The pupal stage is generally passed in the gall, but in some cases in the soil.

Cecidomyia (Rhabdophaga) saliciperda.

This species infests *Salix alba*, *S. fragilis*, *S. caprea*, *S. purpurea*, *S. viminalis*, and, sometimes, the White Poplar, *Populus alba*. Young twigs and also branches up to 3 or 4 inches in diameter are attacked.

Symptoms of infestation are poor leafage, swellings, and later on the rupture of the bark, which hangs down in shreds.

Description.

The *fly* (Fig. 1) measures about $\frac{1}{8}$ inch in length; its head and thorax are black, or black-brown, with black hairs; the wings are milky white, with whitish hairs.

The *eggs* are extremely minute, rounded at the ends, and orange yellow in colour.

The *larva* (Fig. 2) is rounded at both ends, or somewhat spindle-shaped, and has a well marked anchor-process.

The *pupa* is yellow, and has two small brown projections at the base of the antennæ.

Life History.

The female deposits her eggs in chains or rows on the bark The larvæ on hatching bore into the bark (Fig. 3), and owing to their irritating presence the cambium gives rise to irregular streak-like growths, through which the larvæ make excavations or irregular galleries. Between the larval galleries the wood is normal in condition. Perhaps the activity of the cambium may serve to enclose the larvæ without marked boring on their part.

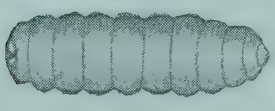


FIG. 2.

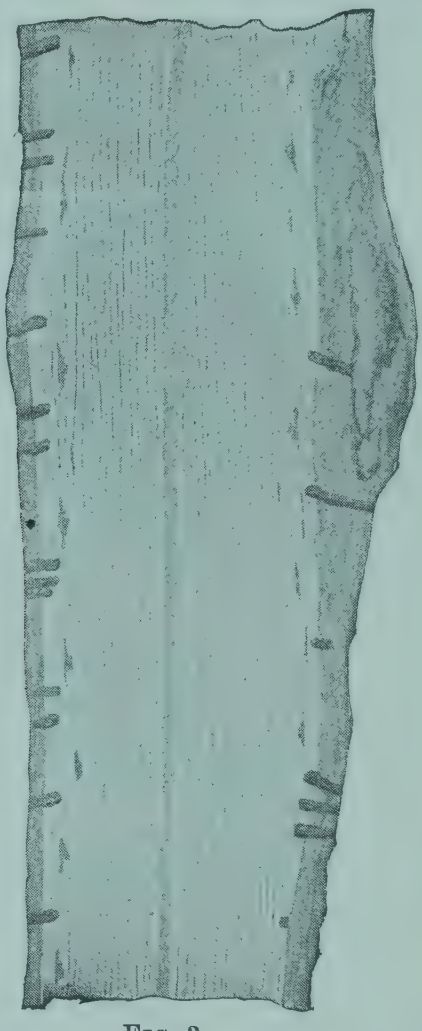


FIG. 4. FIG. 3.

FIG. 2.—Larva of *C. saliciperda*, after preservation, greatly magnified. FIG. 3.—Longitudinal section of *Salix alba*, showing larval tunnels of *C. saliciperda*, natural size. FIG. 4.—Piece of *Salix alba* showing flight holes of adult *C. saliciperda*, natural size.

For a time the bark stretches, accommodating itself to the increased thickening, so that only spindle-shaped swellings show, but ultimately it ruptures and hangs down in shreds. Pupation takes place just under the bark, which is easily knocked through by the forehead of the pupa.

After the issue of the flies the bark may be seen riddled with small holes (Fig. 4). There is one generation in the year, the larvæ tunnelling from July till the next April, May, or June.

Preventive and Remedial Measures.

1. Cut off and burn infested shoots before the issue of the flies.
2. Cut out infested pieces and burn them.
3. Apply cart grease or some similar substance to the places attacked, and although the pupæ may occasionally push themselves through this, the flies will be entangled in the sticky material.

Cecidomyia (Rhabdophaga) salicis.

This gall-gnat is the cause of spindle-shaped or lemon-shaped galls on the one-year twigs of *S. cinerea*, *S. caprea*, *S. purpurea*, *S. aurita*, and *S. viminalis*.

Both leading and side shoots may be infested. The twigs fail to grow; they may become angled and are rendered useless for basket-making or wicker-work.

The galls are caused by an enlargement of the pith.

Description and Life History.

The *flies* are black, with two stripes of white hairs, and measure about $\frac{1}{4}$ inch in spread of wings. They deposit their eggs in little heaps, and in the many-chambered gall the yellow-red larvæ may be found, in number up to 30. Pupation takes place just below an outside skin, which is broken through for the exit of the adult gnat. Issue of adults may take place from the end of May onwards.

To prevent attack on the shoots to be formed during the ensuing season cut away and burn the galls before the flight of the adults.

Cecidomyia (Rhabdophaga) rosaria.

The galls of this insect are typical of a series, in which the malformations at the ends of the twigs hinder the normal increase in length of the branches.

The galls of *C. rosaria* are rose-shaped and are found at the ends of the shoots of *S. caprea*, *S. aurita*, *S. alba*, *S. purpurea*, *S. cinerea*. The fly is black, with greyish wings, and has silvery hairs on the thorax.

In late spring or early summer the egg is laid in the developing terminal bud, and, the internodes failing to develop, the leaves remain drawn together in a rosette.

When the other leaves fall in autumn, those of the gall remain, brown and withered looking. Pupation takes place in the gall.

Cecidomyia (Dasyneura) terminalis.

This brown-black fly is the cause of the swollen galls at the apices of the shoots of *S. fragilis* and *S. alba*.

As many as 20 to 30 larvæ may be found in the gall.

Cecidomyia (Rhabdophaga) heterobia.

FIG. 5.—Galls of *Cecidomyia heterobia* on *Salix triandra* (two-thirds natural size)

This gall-gnat is the cause of the rosette galls (Fig. 5) at the apices of the shoots of *S. triandra* and *S. cineria*, and of the galls on the male catkins of *S. amygdalina*.

The infested catkins are deformed, while the presence of the larvæ at the apices of the shoots prevents shoot development.

This gall-gnat is dusky-brown to black in colour, with the under surface of the abdomen yellow. Pupation takes place in the gall. The damage, as in 1904, may be very great.

The varieties of osier chiefly attacked by this insect are known in the trade as Norfolks, Black Mauls or Mules, and Spaniards, these all being varieties of *S. triandra*.

The remedial measure is to cut away the galls and burn the enclosed brood.

Cecidomyia (Dasyneura) marginem-torquens.

This gall-gnat may be mentioned as a type of those that cause galls on leaves. The galls occur at the edges of the leaves, and as there may be many side by side—one larva to each gall—the leaf edges are rolled. *Salix viminalis* is a favourite host plant, but *S. fragilis* may be infested, and there is a record of attack on *S. caprea*.

4. Whitehall Place, London, S.W.,
May, 1906.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Some Common Thistles.

In another leaflet* a general account is given regarding the dangers of weeds, the manner of their distribution, and the methods by which they may be suppressed. Inasmuch as certain species, however, demand special measures, it is proposed in the present leaflet to describe several of the commoner species of thistle which arrest the farmer's attention both on arable and pasture land, and to point out how they may be dealt with in a systematic manner. These pests are : (1) *The Spear Thistle*, (2) *The Welted Thistle*, (3) *The Marsh Thistle*, (4) *The Creeping Thistle*, (5) *The Stemless, Dwarf or Chalk Thistle*, (6) *The Annual Sow Thistle*, and (7) *The Perennial Sow Thistle.* The spear, marsh, creeping and stemless thistles have each hair of the down or pappus which is attached to the "seed," branched somewhat like a feather, while the hair of the down of the other three species named is simple.

All the species flower during the summer months, between July and September, but while the Annual Sow Thistle may flower in June, the Perennial Sow Thistle and the Stemless Thistle flower late, about August and September.

Description.

1.—The Spear Thistle (*Cnicus lanceolatus*, Willd.) is the strongest of the plants mentioned, and grows usually from 2½ ft. to 4 ft. high (Fig. 1). Its root is a well-developed tap-root, which descends from 9 in. to 1 ft. into the soil, and bears few lateral roots. One or two very strong adventitious roots, however, are often produced near the surface of the ground. The upright stem is stiff, and the spines on the edges of the leaves are long and stout. There are also short stiff spines on the upper surface of the leaves, and long ones on the bracts forming the involucre of the flower-head. The flower-heads are erect and comparatively few, and are placed either singly or two or three clustered together at the end of the branches. Each head is about 1 in. to 1½ in. in diameter,

* Leaflet No. 112. Weeds and their Suppression.

with pale crimson-purple flowers (Fig. 2). The plant produces seeds freely, and these germinate very easily in two or three days when they are placed in suitable soil. The

FIG. 1.—SPEAR THISTLE (*Cnicus lanceolatus*, Willd.), clearly showing its spinous character.

spear thistle as met with in the fields is usually a biennial. Seedlings have, however, been artificially flowered in one season, but such plants did not ripen seeds satisfactorily, and

were destroyed by frost in the autumn. Ordinarily the plant during the first season of growth produces a compact rosette of ovate-lanceolate leaves lying close to the ground. In the second year a central stem is sent up, which branches and bears flower-heads in which seeds are produced. After the latter are ripe the plant dies. The seeds, however, are borne away from the parent plant by means of the feathery

FIG. 2.—HEAD OF SPEAR THISTLE (*Cnicus lanceolatus*, Willd.), about natural size.

down or pappus. The distance which the seed is carried is comparatively short, usually less than 30 or 40 yards rather than beyond this distance, and it varies with the state of the weather. On dry, hot days the seed separates or dries off the pappus almost as soon as it escapes from the

flower-head and drops to the ground close to the plant, the pappus floating away without its load. Most of the thistle down seen floating on windy days bears no seed. The spear thistle is very common on roadsides, and in pastures and meadows on almost all kinds of soil throughout the country.

2.—The Welted Thistle (*Carduus crispus*, L.) is an annual or biennial plant, not so commonly distributed as the preceding one, and it gives little trouble to the farmer. The tap-root is smaller and the stems more slender than those of

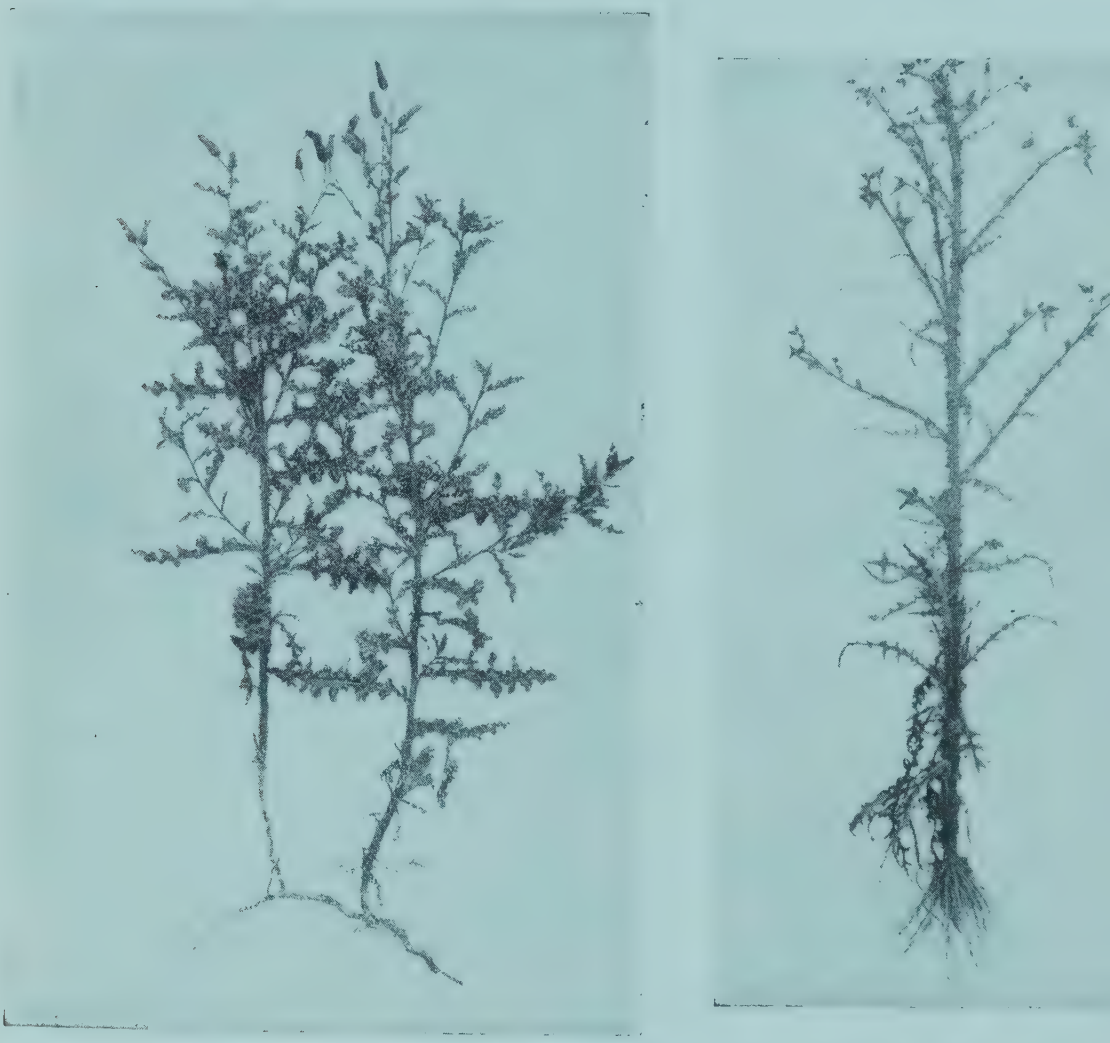


Fig. 3.—*Left :* Creeping Thistle (*Cnicus arvensis*. Hoffm.) ; *Right :* Marsh Thistl (*Cnicus palustris*, Willd.).

the spear thistle. The stem is erect, about 1 ft. to 3 ft. high, winged, and covered with fine spines. The leaves and involucre are also covered with spines. The flower-heads (Fig. 6*d*) are roundish, clustered together at the end of the branches, and bear purplish-crimson flowers. The seeds germinate very readily, and the young plants somewhat resemble those of the spear thistle.

3.—The Marsh Thistle (*Cnicus palustris*, Willd.) is one of the commonest species, and is met with all through the country on damp undrained pastures and by the sides of ditches. The root-system of the plant consists of a series of fibrous roots all about the same thickness. The stem (Fig. 3) is erect and branched, somewhat slender and soft, with numerous short spines upon its wings. The whole plant is of a dull green or greenish-purple tint. The flower-heads (Fig. 6*c*) are small, about ½ in. in diameter, and bear dark purplish-crimson flowers. The involucre is practically spineless and similar in colour to the stem. The plant is a biennial. During the first season a compact rosette of leaves is formed close to the ground, from which an erect stem is sent up in the second year. The seeds are pale straw-coloured, and only germinate satisfactorily under the peculiar acid conditions of marshy, damp soil.

Fig. 4.—Creeping Thistle. Seedling 9 weeks old (slightly reduced).

4.—The Creeping Thistle (*Cnicus arvensis*, Hoffm.) is the commonest and most troublesome of all thistles (Fig. 3). It grows abundantly on all sorts of arable land and pastures throughout Europe. It is a perennial plant, exhibiting many remarkable structural and biological features. The flowers have an odour very strongly resembling that of honey, and quite distinct from that of other species. In the thistles previously mentioned each flower in the head possesses anthers which bear pollen, and an ovary capable of producing seed. Moreover, in these species seed is abundantly produced in each head of flowers. The creeping thistle has, however, two distinct types of flower-head. In one of these

of thistle. A thin tap-root descends vertically into the ground, and in a very few weeks—long before the cotyledons decay—adventitious buds are produced upon it (Fig. 4), and also upon the lateral secondary roots in great abundance. The root-system (Fig. 5) develops in all directions very extensively

FIG. 8.—ANNUAL SOW THISTLE (*Sonchus oleraceus*, L.).

both in young and old plants, and upon all parts of it buds arise which ultimately come above ground and grow into strong, leafy stems. To make matters worse from the farmers' point of view the roots are often very deeply seated

in the soil, while small broken pieces easily take root and become new plants. Though the creeping underground parts, from which the thistle gets its common name, look very much like rhizomes, they are true roots, which bear buds ; no rhizomes are produced. The stems and leaves, both of seedlings and mature plants, are very sensitive to frost. The first frosts of November and December kill off all the green parts above ground, but the buds on the roots below are uninjured, and it is from these that the plant is chiefly propagated.

5.—The Stemless or Dwarf Thistle (*Cnicus acaulis*, Willd.), sometimes termed the Chalk Thistle from its habit of growing freely in pastures over chalk, may be at once recognised by its spreading rosette or tuft of very prickly smooth leaves, its almost stemless or sessile flower-heads, and its extensively creeping rootstock (Fig. 7). It is a perennial which sometimes occurs plentifully in dry pastures over gravel and chalk in the southern and central midland counties of England. The rosettes of leaves destroy the patch of herbage which they cover.

6.—The Annual Sow Thistle (*Sonchus oleraceus*, L.) is a weed which causes considerable trouble in arable land. It is an erect plant which may attain three feet in height, and has a tubular grooved stem, which is branched, smooth, and shiny (Fig. 8). The leaves are bright green, the lower ones being stalked and much lobed, the upper lobed, or entire and angular, and clasping the stem. The yellow flowers, which appear in summer between June and September, are borne in crowded "heads," which are smooth or slightly cottony. The fruit is attached to a simple hairy pappus, which enables it easily to be borne away and distributed by the wind ; it should be remembered that this weed is only propagated by seed. It is widely distributed on most soils, but appears to grow most freely on medium sandy and calcareous loams.

7.—The Perennial or Corn Sow Thistle (*Sonchus arvensis*, L.) may be at once distinguished from the Annual species in the mature stage by means of its extensively creeping rootstocks and much larger flowers. It attains 2 to 4 ft. in height ; the stem is tubular and angular and clothed with yellow sticky hairs in its upper part ; the leaves are wavy and toothed, but very variable ; and the heads of yellow flowers are rather hairy, and 1 to 2 inches in diameter. It spreads both by seed and by the creeping rootstock. The flowers open later than in the case of *S. oleraceus*, in August and September, at which time the latter species is producing seed. The Perennial Sow Thistle is a vigorous grower, occurs on all soils in arable land, and may occasion great

trouble and damage. Its presence is frequently manifested in corn crops in late summer, when the large yellow flower-heads are very conspicuous.

Methods for the Extermination of Thistles.

The methods adopted for the destruction of thistles, if they are to be of any use, must take into consideration the life-history of the plant. The old rhyme which advises leaving the cutting of thistles until July is excellent so far as the spear, welted, and marsh thistles are concerned, but it is absolutely useless for the checking of the creeping thistle. In fact general advice for all kinds of thistles is valueless.

1.—*Destruction of Spear, Welted and Marsh Thistles.*—The spear, welted, and marsh thistles are all biennials and can be destroyed by the same methods. Each plant grows but two seasons, at the end of which it exhausts itself in seed production and dies. *In the case of these three thistles seeding must be prevented. This can be done by cutting with a spud below ground, or with a scythe, sickle, mowing machine or thistle-cutter above ground in late June or July,* when the plants have sent up their flowering stems, and before the flowers have opened. Cut at this time they die (as they would do in another month or two in any case) and seed is not formed. This plan effectually gets rid of plants which are in their second season of growth. Seedlings must, however, be dealt with also. These are best spudded in meadows and pastures in late autumn and in spring. At this time they are in the form of a rosette close to the ground. In cutting with the spud or similar instrument it is important to be certain that the roots of the plant are cut through below the bud part from which the leaves arise. It must also be borne in mind that in the case of the marsh thistle there are a number of roots to be severed, and the spear thistle and welted thistle often have more than one strong root. Sometimes one of the roots is cut and the other left, but this is quite useless. *To make certain of the result, the spud should be driven well below the surface of the land and the severed rosette of leaves turned upside down.* It is easily done, and requires no more time than slovenly work. Cutting at these definite times of the year, namely, in autumn and spring for the eradication of the young plants, and in June or July for the destruction of the old ones so as to prevent seeding, is all that is necessary in the case of the three kinds of thistles mentioned.

2.—*Destruction of Creeping Thistle.*—The creeping thistle cannot be destroyed by the methods outlined above. Seeding must, of course, be prevented, but to wait until June or July before cutting is an excellent way of keeping this pest in a state of robust health. During the summer the plants manufacture a large amount of food-material in their leaves,

and this is transferred and stored below ground in the roots and root buds. Comparatively little seed is produced, and little of the stored food is needed for it. To cut off the stems after this storage has taken place has no exhausting effect on the crop, and the mowing of this kind of thistle once or twice *late in the season* can be practised for years without diminishing its vigour. *To cope with the creeping thistle it must be cut early in the year, soon after it comes above ground, and the cutting should be repeated as frequently as possible throughout the season.* For every shoot sent above ground the thistle uses some of its stored material, and if the stems and leaves, which are the plant's machinery for making more food, are destroyed as soon as they appear, exhaustion and death certainly result. Both old and young plants must be dealt with in this way. *Faithful systematic cutting with the spud or scythe in meadows and pastures throughout two seasons, or the growth of a couple of root crops in succession where the weed is very prevalent in arable land, is a sure plan of getting rid of this most troublesome agricultural pest.*

Experiments conducted at the Harper-Adams Agricultural College in 1907, 1908 and 1909, showed that the Creeping Thistle may be destroyed in three years in grass land by cutting three times in the first and second seasons (in early June, late July, and once later), and twice in the third year (in early June and late July). Cutting was found to be best done when the plants were 4 to 6 inches above ground.

In the United States it has been found that small patches of the Creeping Thistle may be destroyed by covering the plot of infested ground with large sheets of strong tarred paper, securely fastened down with pegs and large stones. Light is excluded and all vegetation beneath the paper is destroyed.

3.—*Destruction of Stemless Thistle.*—The creeping rootstock and almost stemless character of this thistle combine to make eradication extremely difficult, for it is a perennial which stores food in the same way as the Creeping Thistle. It is not tall enough to be cut with the scythe or other implement, and it sometimes occurs in such numbers that continual spudding is a most tedious and expensive operation. Spudding, however, is the only practical mechanical remedy, and should be repeated throughout the summer months. An endeavour should at the same time be made to improve the general herbage by manurial treatment, and thus crowd out the low-growing thistle. Isolated patches might be dealt with by the tarred paper method mentioned above, but the bare spots would need reseeding with grass and clover seeds afterwards.

4.—*Destruction of the Annual Sow Thistle.*—As this thistle is an annual only propagated by seed, it is clear that where it occurs, either in small or large quantity, the first thing to be considered is the prevention of seeding, and to this end it is important that the plants should be cut down before the flowers appear. The cutting of the plants, moreover, should not be confined to the fields actually infested, but (as with all other species of thistles) should extend to any waste land which may be adjacent, for such land is usually a fertile source of the thousands of plants which are found in cultivated fields. Cutting off with the hoe below the surface of the soil, or pulling up by hand, is equally effective in destroying the annual sow thistle. The easiest time for hand-pulling is when rain has softened the ground, and in corn crops this is doubtless the most expedient method. The regular and thorough hoeing generally practised will keep this weed down in root crops, and the same remark applies to garden cultivation. Surface cultivation with the harrow in spring destroys thousands of the seedlings.

5.—*Destruction of the Perennial Sow Thistle.*—This species may be combated in the same way as the Creeping Thistle (*Cnicus arvensis*), as its habits are very similar, it being propagated by seed and by creeping rootstocks which store up food during the period of growth in summer. A short rotation, with thorough cultivation and the free use of the hoe in two or three successive root crops, is perhaps the most certain means of killing this pest. Badly infested land may be laid down to grass for a few years, when the weed will be crowded out. Small patches may be destroyed by the use of tarred paper, as in the case of the Creeping Thistle.

Heavy crops of lucerne, vetches and maize tend to crowd out thistles of all kinds, and where it can be grown successfully maize is especially useful, as it casts a dense shade and is thoroughly hoed.

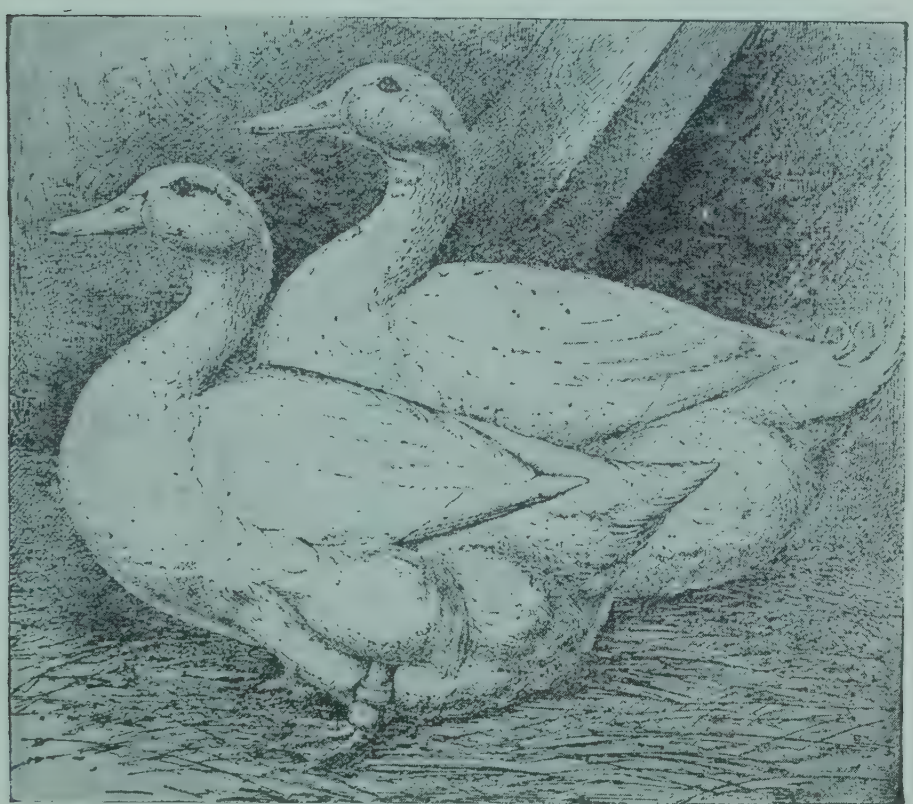
4, Whitehall Place, London, S.W.,
May, 1906.
Revised, September, 1910.

Other Leaflets on Weeds published by the Board are :—

No. 63.—The Destruction of Charlock.
No. 112.—Weeds and their Suppression.
No. 180.—Dodder.
No. 194.—Coltsfoot.
No. 222.—Meadow Saffron.
No. 226.—Broom-rape.

BOARD OF AGRICULTURE AND FISHERIES.

Ducks and Duck-Breeding.



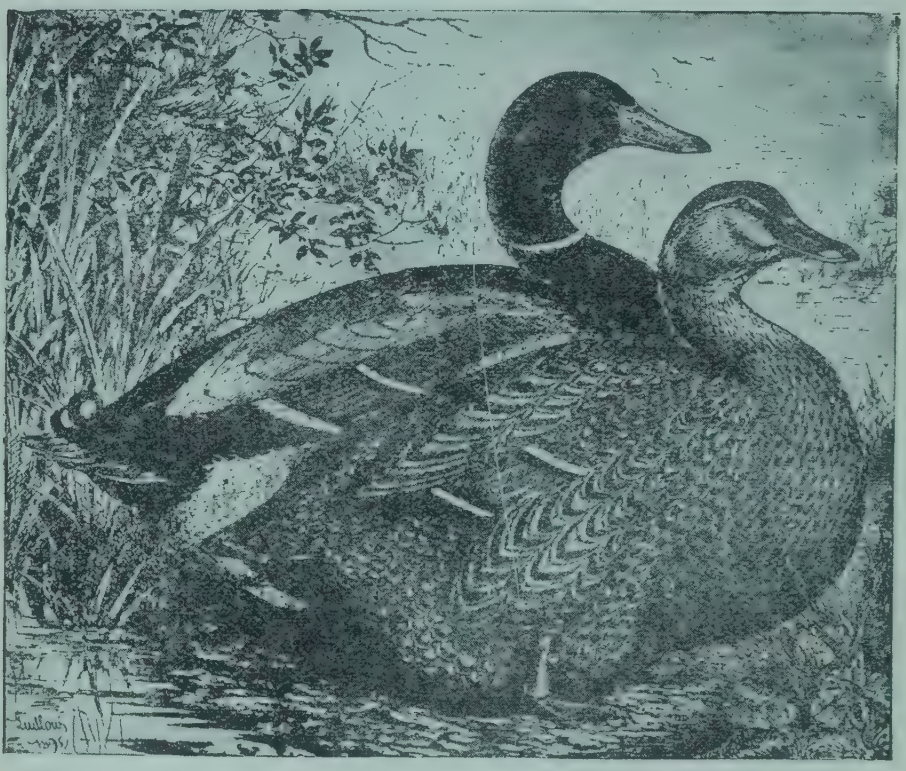
AYLESBURY DUCKS.

All species of live stock possess individual qualities, which require to be studied carefully if the greatest amount of success is to be attained. No fact is more apparent in connection with stock raising than that the conditions under which the stock are kept must be in conformity with the nature of the animals concerned. The diversity of soil and climate, which is so marked a feature of the British Islands, explains why there is such a great variation in the stock of the country, and why our farmers have succeeded in placing themselves in the front rank as breeders of high-class animals of all kinds. What is true in regard to horses, cattle, and pigs, is equally so with the different classes of feathered stock.

In this leaflet it is proposed to deal with the chief breeds of ducks, their rearing, management, and preparation for market.

The Breeds of Ducks.

The Aylesbury.—Some old writers speak of the Aylesbury duck as the White English, designating the Rouen as the "common" duck. But in the early part of the nineteenth century the name Aylesbury was given to the white variety, owing to the fact that it was extensively bred in the Vale of Aylesbury, until recent years the chief seat of the duck-breeding industry. For nearly a century this variety has supplied ducklings to meet the demand in the early months of the year, when prices are high, and for this special trade it has practically no rivals among the pure breeds of this or any other country. The chief reason for its superiority in this respect is its rapid growth. Duck-

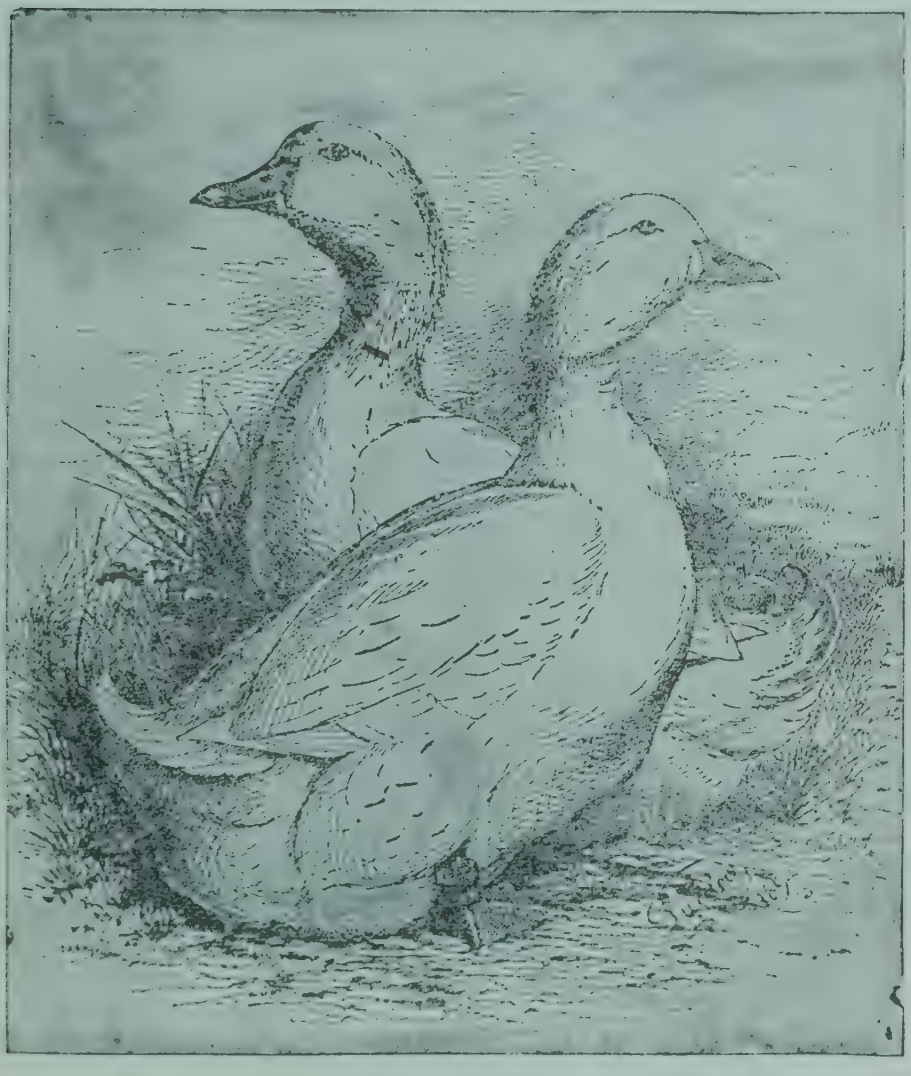


Rouen Ducks.

lings can be produced ready for killing at seven to nine weeks old weighing four to five-and-a-half pounds. No other breed will accomplish like results in so short a time, and early maturity is important to the breeder of ducks, which are very heavy feeders. The bones in this breed are very light, and there is comparatively little offal, while the flesh is well placed and light in colour.

Adult drakes weigh about 9 lb., and ducks 8 lb., but for breeding purposes a pound less in each sex is no disadvantage, provided that the frame is large and well developed. The ducks are excellent layers of large-sized eggs, of which they frequently produce considerably over a hundred and twenty per annum.

The Rouen.—This breed possesses many useful qualities, but does not equal the Aylesbury in early maturity. It is much slower in development, and during the early period of growth is engaged in the building of frame rather than the production of flesh. For this reason it is not suitable for the duckling trade, but it provides larger specimens than the Aylesbury, and is chiefly kept for the autumn and winter duck trade. The flesh is excellent, very full-flavoured, and



Pekin Ducks.

when the bird is fully grown, very abundant; it is much darker than that of the Aylesbury, and is richer than that of any of the other domesticated breeds. The Rouen is a good layer of large-sized eggs, but it does not come into profit so early as the Aylesbury. Fully matured specimens weigh: drakes, 10 lb., ducks, 9 lb.

The Pekin.—The Pekin breed was first introduced into Britain in 1872, direct from China, but it was not until two

years later, when other importations by way of America took place, that it fell into the hands of poultry-breeders. The Pekin duck is of attractive appearance, prolific as a layer, and naturally vigorous. Though often larger in frame than the Aylesbury, it does not carry the same quantity of flesh, and an adult specimen generally scales one or two pounds less in weight. Pekins do not readily lend themselves to fattening. As with fowls that are especially prolific as layers, excess in that direction is not accompanied by great meat production, and the flesh of the Pekin is neither so abundant nor so good as that of the Rouen and the Ayles-

INDIAN RUNNER DUCKS.

bury, and it is chiefly valuable as an egg producer. For crossing with the Aylesbury, however, the Pekin is very valuable, and the progeny of such a cross are often larger and quite as rapid in growth as the pure Buckinghamshire breed.

The Indian Runner.—Within the past twenty years a variety of duck to which the name "Indian Runner" has been applied has become of considerable importance to duck breeders, although for something like fifty years ducks of this type have been kept in Cumberland. Upon the farms of that county ducks of this type are freely to be met with, and they are much esteemed on account of their wonderful laying powers, which are greater than those of any other

race of ducks. The eggs are about the same size as hens' eggs. The birds are usually hardy. For table purposes they are small, adults weighing $3\frac{1}{2}$ to $4\frac{1}{2}$ lb., while ducklings would be about 2 lb. lighter; their flesh, however, is excellent. As the name indicates, they are excellent foragers.

In appearance the Indian Runner is peculiar. Combined with the long, upright body, as in the Pekin, it has a very fine long neck, and its head and bill are also long and fine. The body is not so deep as in the breeds already described, much more of the leg being seen. There are two colours: (1) the fawn, and (2) the brown and grey; the former is generally favoured. The head, breast, back, wings, and tail in drakes of these varieties are fawn or brown and grey respectively, with white neck and sides in each case, but the ducks are pencilled.

The Muscovy.—This variety has been known for more than three centuries, and it appears at various times to have been termed the Peruvian and the Barbary duck. The breed has never become popular, firstly because it is not pleasing in appearance, and, secondly, because it has so bad a temper that other fowls can scarcely be kept where it is. On the other hand, the birds become very tame. They cannot be kept in confinement, but must have freedom, and, being great wanderers, they sometimes remain away several days. They grow to a very large size, and drakes will often scale 12 lb. when matured. As layers they are somewhat uncertain.

The Cayuga.—Several attempts have been made to popularize the Cayuga duck, but without success, its small size and dark flesh being serious disadvantages on our markets. It is excellent in meat properties, the darker coloured flesh and full flavour enabling it to take the place of the wild duck. As a layer, except where enfeeblement has resulted from close breeding for exhibition purposes, it is exceedingly good. Crossed with the Pekin, it produces a very good table bird. The body is long and wide, with a flat back and very deep breast; the thighs are short and plump, and the legs short, strong and small; the neck is long, and the head and bill long and rather narrow; the plumage is bright metallic black; and the legs and feet are black or smoky-brown, and the bill blue-black. Adult specimens weigh $6\frac{1}{2}$ to $7\frac{1}{2}$ lb.

Breeding.

The breeding of ducks is especially suited to those who have only a limited amount of space at command, but it is also an industry which can be followed by the farmer. As is well known, this industry is largely developed in Buckinghamshire and Bedfordshire. Within the last few years the

area has extended to a considerable extent, and success has been achieved in other parts of the country, notably where the soil is light and of a gravelly nature. As a general principle, it should be realized that the breeding stock must have access to water in which to disport themselves, and the progeny are much stronger if the parents have liberty. Consequently, in the duck-breeding centres small occupiers who hatch and rear the ducklings do not keep the stock birds, but purchase eggs for hatching. This plan can be generally recommended, as it enables many to undertake the rearing of ducks who would not otherwise be able to do so.

Stock birds should not be forced.—Where ducks are to be kept as stock birds they should be given full liberty after the first fortnight of their existence and allowed free access to water. Development will thus be retarded and the birds will grow slowly as compared with those which are subjected to the forcing treatment; but they will build up a strong frame and a reserve of strength which are essential to their future work as breeding stock. Size is attained ultimately, but not with the same speed, and the birds are not fit for killing as ducklings.

Districts suitable for duck raising.—Districts which are specially suited to the raising of chickens may not be equally favourable for ducks, and those where ducklings can be reared with advantage are generally undesirable for turkeys. Market requirements must, of course, be considered, but it is useless to attempt to force production where natural influences are antagonistic. When the object is the raising of ducklings there can be no question that valleys or well-watered plains are much better than the higher lands, and for the breeding stock the presence of sufficient water in which they can exercise themselves is important. Dry or harsh soils should be avoided, otherwise satisfactory results can hardly be expected.

Space required.—A further question which presents itself for consideration is the amount of space available. Fowls, geese, and turkeys alike are active in habit, and thrive best when they have an abundance of range; fowls, when the adult stage has been reached, may be confined to a relatively small area, especially where egg production is the main object, but this is at best an expedient which has its limitations. Geese and turkeys, both old and young, must have free range. Hence they are essentially farmers' fowls, only to be kept by those who are not limited to a small area of land. To attempt the rearing of these birds under conditions which are sufficient for chickens and ducks would be to court disaster.

Ducks occupy a place by themselves. Whilst the older birds—the breeding stock—thrive all the better for plenty of space and for an abundance of water, the youngsters can be massed together to an extent which would be fatal to any other class of poultry. During the duckling stage, when they are fed for early development, they appear to be able to sustain forcing for a longer period than any other species of poultry, and the desire to wander is apparently dormant. Further, they appear to be less influenced by the injurious effects of tainted ground than are chickens or young turkeys. The "duckers" of the Vale of Aylesbury and surrounding districts have for very many years been able to rear large numbers of ducklings upon small areas, where the birds are crowded together with no ill results such as would be expected if like methods were adopted with chickens. Duck farming, therefore, presents special advantages to the occupier of a small area of land, as he can raise a much larger number of birds per acre per annum than would be possible with other kinds of poultry.

Buying eggs for hatching.—Upon some of the establishments in America where duck raising on a large scale is followed it is customary to keep large numbers of adult birds for breeding, up to as many as 500. These are divided into flocks of about fifty, of which ten or fifteen are drakes. The drakes are by no means quarrelsome, but appear to live peaceably with each other. The capital expenditure for houses is therefore much less than with any other class of poultry. In the Oudenarde district of Belgium, where duck raising is a very important industry, the breeders are usually small farmers, who do not keep large flocks, but allow their birds to run together. In Britain a different system prevails from that met with in either of the countries named, for as a rule, the duck raisers do not keep the breeding stock, but purchase eggs for hatching from farmers and others. Such a division of labour has many advantages. In America land is cheaper and more plentiful, whilst in Belgium the open lands afford an opportunity for dispersion of the birds, which would not be possible to a like extent in Great Britain. Probably, however, the chief reason why duck raisers in Britain usually buy their eggs is that originally they were mainly small occupiers who could not attempt to keep both breeding stock and youngsters, on account of the amount of space required for the former. It has, therefore, been found more profitable to leave the work of breeding to others, and to purchase the eggs, confining attention to the work from the time hatching commences. By so doing the ground can be left vacant for several months of the year, although many of the "duckers" do not trouble themselves in that direction, as the birds have no access to grass at any period of their existence. What is found to be almost a necessity with "duckers" has proved equally desirable where operations

have been on a larger scale. The one point in favour of the American plan is that the race or quality of the stock can be controlled, but on all other grounds the plan adopted in this country is preferable, as the breeding stock is kept by ordinary farmers under more natural conditions, and the ducklings are hardier. One of the largest duck raisers in this country does not keep any breeding stock, relying entirely on purchased eggs to the number of about 50,000 per annum. Ducks are kept in the district around this farm to an extent not known elsewhere, although a sufficient supply of eggs is not yet obtainable locally—in fact, the difficulty in obtaining eggs has been considerable.

Hatching and Rearing.

System of Hatching.—In Britain the system of hatching has until quite recently been entirely by means of hens, artificial methods not being favourably regarded in the duck districts of Buckinghamshire and Bedfordshire. Though this feeling is not so pronounced as formerly, incubators having been used within the last few years by progressive duck breeders, the majority still regard the natural method of hatching as alone calculated to secure success. Where the ordinary system is retained, hens—not ducks—are used for hatching, as it is recognised that ducks are unreliable and late in becoming broody, and are, therefore, of no use for producing early birds. Up to a few years ago it was considered doubtful whether artificial incubation would give as good results with ducklings as with chickens, but American and British breeders have since proved that duck-hatching upon a large scale by means of incubators can be made successful, and that for bringing out these birds in a wholesale fashion it is the only method which can be depended upon. Artificial incubation has proved quite reliable if a plentiful supply of fresh air is ensured and the eggs are damped daily. Formerly the great difficulty was to rear the artificially-hatched ducklings, but the process is now better understood. The period of incubation is 28 days.

Ducklings require heat for a much shorter period than do chickens; during ordinary weather a week to ten days is quite sufficient, but when the weather is severe they may be retained in heated brooders for a few days longer. They are frequently raised without any heat at all in the mild season, being simply kept in small boxes, wherein their own body heat is sufficient, but it is wise to be on the safe side.

Housing.—Ducklings can bear a considerable amount of exposure after they are three weeks old; they should always have an abundance of fresh air. Many "duckers" keep them in houses built like pigsties, with an open yard in front. Another method is to enclose plots of ground, about

eight to the acre, with wire-netting a foot in height. In each run is placed a small house, which may be of the simplest character. Packing cases answer excellently for the purpose with a little alteration, the lid forming the door, and a few holes being made for ventilation, additional cases being provided as the inmates require increased accommodation. But during the later part of the period of growth such protection can be dispensed with, and they may be allowed to remain in the open day and night. Under such conditions it is sometimes necessary during the prevalence of high winds or driving rain to hang sacking over the netting as a measure of shelter. In America more elaborate provision is made, long ranges of shedding being provided, divided inside into compartments by boards a foot high, and having small runs outside formed by wire-netting. Sheds of this description also exist in this country. Under such a system there must be a considerable waste in the manure produced, and an increased danger of the runs becoming tainted. As these large houses cannot be moved the plan of moveable pens is to be preferred, and the same ground should not be used for the ducks for more than four years. The cost of removal of runs is small, and is more than compensated for by the crops or feed secured owing to the fertilising properties of the manure.

Water not required for ducklings for fattening.—The absence of what is their natural element does not decrease the productiveness of ducks, but it is found that ducklings bred from birds kept entirely on the land are less vigorous, do not grow nearly so fast, and are more subject to disease. It is therefore advised above that stock birds should be allowed access to water after they are a fortnight old. But so far as young birds for the table are concerned they grow more rapidly if they are denied water except for drinking purposes. The great majority of English ducklings marketed during the spring and early summer have never been in water, though sometimes "duckers" allow the young birds a bath a day or two before they are killed.

Feeding.

Ducks.—Ducks are rather gross feeders, and experiments in America have supported experience in Great Britain that nitrogenous food is essential to ensure a plentiful supply of eggs and fertility. Their natural food consists largely of slugs, worms, &c. Hence flesh is desirable. During the breeding season old ducks should not be supplied with food of a fattening nature. The most suitable food is barley meal mixed with an equal portion of thirds or fine sharps, and to this should be added some cooked lean meat. Butcher's offal, when not fatty, is excellent for the purpose. The food should be given warm and of the consistency of

stiff porridge. Where the birds are at liberty they only require two meals per diem, early in the morning and about an hour before dusk. Near by must be water for them to drink, or they will not feed properly.

Ducklings.—In feeding ducklings, as great a variety of food as possible should be supplied. Barley meal, cheap oatmeal, boiled rice, each with about one-fourth of fine sharps, will afford change of diet. But with these should be mixed cooked lean meat or tallow greaves, unless a plentiful supply of worms is obtainable. In the duck districts tallow greaves are largely employed, but in many places carcases of animals can be obtained. If the ducklings are to be reared for stock birds, the food recommended should be continued until they are fully matured. Indian meal is often used on account of its low price, but it is deficient in albuminoids, and should be fortified in that direction by lean meat.

Fattening.

Where the ducklings are to be killed at an early age, the system referred to above is only continued for five weeks, by which time the birds will have grown considerably. The system of feeding is then changed, with the object of filling up the frame.

The final stage in the growth of ducklings preparing for market is one of very rapid development. The food which yields the best result is rice properly cooked and mixed with about one-fourth its bulk of tallow greaves or meat. At this period fatty material is essential to soften the flesh. Barley meal, buckwheat meal, and Indian meal are often used instead of the rice, but they do not yield the same result. In preparing the rice, one gallon should be added to four gallons of water and about four pounds of the greaves or meat. This mixture should be gently simmered until the rice has absorbed all the water, when it should be soft, yet not a mush. In order to aid digestion the birds should have a plentiful supply of coarse grit or fine gravel, without which much of the food will be lost and the ducklings will not fatten, the cost of production being thus greatly enhanced. Green food is also valuable, and almost any garden stuff is good for the purpose. The birds should be fed three times a day, the object being to encourage eating, so that quick growth may be secured. During warm weather nettles are often boiled and mixed with the food. Upon rice, given as recommended, ducklings are produced weighing from 4 to 5½ lb. at eight to nine weeks old. Rapid growth is essential to ensure success in the duckling trade. The birds must be killed before they are nine weeks old, for there is then a change of feather, which, when completed, reduces their market value, as they are no longer regarded as ducklings. The chief demand for ducklings is from February to July.

Killing and Plucking.

When sufficiently fatted the birds are starved for twenty-four hours and killed by dislocation of the neck. Plucking should take place immediately, while the body is warm. If killed at the right age the feathers come out easily and cleanly. During the cooling process the birds should be placed under boards and weighted, to compress the body and force the meat on to the breast. They must not be packed until quite cold, otherwise they will deteriorate in quality. Feathers should be carefully sorted, and are of considerable value if divided into (1) down, (2) feathers from the back of the neck, and (3) wing feathers.

Duck raising affords a profitable pursuit to small holders, and it is equally suited to farmers who are willing and able to give the necessary time and attention to the birds, and who can obtain a supply of eggs at the right season. But it is an industry which entails both hard work and skill in handling large numbers of birds for several months of the year.

4, Whitehall Place, London, S.W.,
June, 1906.

Revised, August, 1907.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 168.

BOARD OF AGRICULTURE AND FISHERIES.

Hints on the Formation of Permanent Pastures.

It is difficult to give precise rules for laying down land to grass; the treatment must vary greatly under different conditions. From fifteen to twenty species of plants are usually included in the mixture for permanent pastures, and it is clear, that not only will the final result depend upon the species chosen, and upon the proportions in which they were originally present, but also on the soil, the manure, the seasons, and the manner in which the pastures have been grazed.

Preparation of the Land.

Before the subject of the seeds-mixture proper is considered it will be convenient to refer briefly to some points connected with the preparation of the land. Good grass seeds are expensive, but bad grass seeds are still more so, and hence the only way in which the cost of any particular mixture may be lessened is by reducing the seed-rate. It is plain that if the number of seeds is reduced, close attention must be given to the preliminary cultivation. In the first place, it is necessary that the soil should be thoroughly cleaned, and that annual weeds, as well as couch, should be destroyed. Small and slow-growing grasses are much more readily injured by annuals than are such vigorous plants as wheat or oats. In the second place, a fine tilth and a fine surface will be necessary. If the ground is rough, a number of the seeds must perish; bare patches will thus be formed, which will subsequently extend and disfigure the pasture. If the soil is soft and open, seeds may be buried too deeply, and the "plant" will be thin. A further important consideration in preparing land for grass and clover plants, is the manurial condition of the soil. Although grasses are benefited by nitrogenous manures, it will seldom be desirable to apply such manures, either just before or immediately after sowing the seeds. The first effect of the manuring would be to increase the quantity of straw produced by the corn crop with which the seeds have been sown, and thus to repress rather than aid the young pasture plants. Phosphatic manures, such as basic slag or superphosphate, on the other hand, should be used liberally, and may perhaps be best applied to the preceding root crop. If the root crop has not received either of these artificial manures, one or other may be worked into the land in the winter months before sowing the seeds. In dry districts and on light soils, 3–5 cwt. of superphosphate should be applied, but for most soils, 4–6 cwt. of basic slag may be recommended. This

manure may be applied at any time between November and February. If farmyard manure has been used freely (12–15 tons per acre) for the root crop, and if part of this crop has been consumed on the land, a potash manure may usually be dispensed with ; and even where roots have been carted off, potash manures are not likely to be required before sowing, except on light gravelly, or on light peaty soils.

How to buy Grass Seeds.

The purchasers of grass seeds may broadly be divided into two classes, those who let others choose their seeds-mixture, and those who select their own. First, there are those who have no knowledge of grasses, and who, for various reasons, are unable to give the subject personal consideration. This large class may be recommended to go to those seedsmen who have made grasses a speciality, state their requirements, and leave the selection of the seeds to the merchant. The cautions which may be given to a farmer of this class are the following :—Be quite sure of your seedsman, remember that grass seeds are liable to impurities, and are frequently of low quality ; further, that these defects though easily detected by the expert, may not be within the knowledge of the ordinary trader. A merchant may be perfectly honest, but if he has not given close attention to grass seeds and their impurities he may supply unsatisfactory seeds. When quotations are asked for, the seeds of the best seedsmen may appear to be expensive, but a man who has no special knowledge must pay for the special knowledge of others, and in the case of grass seeds, this knowledge is usually well worth paying for.

The mixtures prepared by our seedsmen are compounded on the principle of sowing down a full supply of every plant which is likely to suit the soil. These mixtures usually furnish from sixteen to twenty millions of seeds per acre and cost 20*s*. to 40*s*. The only method of reducing the cost—which can be recommended to the farmer who is ignorant of the grasses—is to sow less seed, say 20 lb. to 30 lb. instead of the 30 lb. to 40 lb. usually put in. The seedsman recommends 30 lb. to 40 lb. for soils in "fair average condition," but if by skilful tillage and manuring the land is got into first-rate order, the quantity to be sown may safely be reduced. By sowing good seeds, and by farming well, the farmer who has no special knowledge may succeed in forming good pastures, even upon land of medium quality ; but he cannot expect to obtain either the best or the most economical results, and he will seldom succeed, on poor land, or upon land that has not been liberally manured. To be successful in forming pastures, the farmer must understand the special cultivation required by pasture plants, and must treat them with the same intelligence that he now bestows on corn and roots.

The stages in a Pasture's existence.

The hints which follow are addressed to farmers who wish to choose their own seeds, and improve on their present system of laying down land to grass. These hints are based on an article published in the Journal of the Board.* It was pointed out in that article, that a pasture passes through three clearly defined stages of existence, that a somewhat different type of herbage is associated with each stage, and that the management must vary with the type of herbage which may cover the soil at any given time.

The first stage of the pasture's existence lasts for from two to three years, and on almost all soils, rye-grass and red clover predominate in the herbage. The red clover soon begins to disappear, and a rapid change then sets in ; the soil appears to have become exhausted, the rye-grass gets poor and thin, and for a time the deterioration is very marked. This stage of poverty may last for from three or four years on good soil, up to ten or twenty years on poor land ; indeed, on very poor, neglected pastures, this second stage will continue indefinitely. The characteristic of the second stage is the absence of turf, so that everywhere bare soil shows through the herbage. This bareness is nearly always very marked on those pastures on which white clover does not grow freely.

On soils of fair, to good quality, fertility gradually accumulates with rest, and a turf begins to form. This slowly thickens, until on fine land, after an interval of perhaps twenty to thirty years, it forms the rich velvety covering of perennial rye-grass and white clover characteristic of our best pastures ; or it may be the rougher mixture of permanent grasses, clovers, and weeds, which are common on second-rate land.

Seeds-mixtures.

In the article above referred to, it was pointed out that pastures must *grow* old, and that the mere sowing down of plants in the proportion in which they are found, or desired, in old pastures, will not make a pasture either good or permanent. Examples were given of experimental mixtures which had failed, and also of one which had succeeded. The particular mixture which succeeded was one recommended by Mr. R. H. Elliot, of Clifton Park, which had been sown down on a poor clay soil, in one of the experiments conducted by the Cambridge University Department of Agriculture. Mr. Elliot's mixture cost about 40*s.* per acre, and, although it was successful, many farmers would consider it too expensive.

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* Journal of the Board of Agriculture. Vol. XII., October, 1905, p. 385 ; and November, 1905, p. 449.

Mixture for poor clay soils.—The following seeds are therefore suggested for those who require a cheap mixture for sowing upon poor clay soils :—

Plant.	Weight.	Number of Seeds in Thousands.	Cost.*
	lb.		*s.* *d.*
Italian rye-grass	4	1,069	1 4
Perennial rye-grass	3	635	1 0
Timothy	1	1,307	0 6
Cocksfoot	2	809	2 4
Meadow fescue	2	467	1 11
Tall fescue	½	120	0 10
Hard fescue	1	555	0 9
Meadow foxtail	1	441	1 10
Tall oat-grass	½	62	0 6
Golden oat-grass	¼	280	0 10
Rough-stalked meadow grass ...	¾	1,626	1 2
Smooth-stalked meadow grass ...	¾	1,085	0 11
Crested dogstail	¼	210	0 5
Perennial red clover	1½	320	2 1
Alsyke clover	1½	1,055	1 8
White clover	2	1,434	2 1
Lucerne	1	219	1 0
Common sainfoin (unmilled) ...	5	110	1 4
Burnet	4	259	2 4
Chicory	1	284	1 0
Yarrow	⅛	417	0 9
Total	33⅛	12,764	26 7

The reasons for recommending the foregoing mixture of seeds are ;—

(1.) It is desirable to include in a mixture for a permanent pasture, all good plants that have any chance of success. Some may disappear, but if they survive all will be of use, especially in the second stage of the pasture's growth. Sainfoin and lucerne are only suitable for a southern climate, and they would not grow upon a stiff, undrained, clay soil ; but if the subsoil contains an abundance of chalk, they may be recommended.

(2.) Both rye-grasses have been included, because they are quick-growing plants which cover the surface during the first two or three years. A covering is absolutely necessary on clay soils in dry districts, for if the sun gets at the soil, many of the less vigorous plants are destroyed before they have time to become established. The quantity of rye-grass recommended is small, because thick seeding tends to choke out all other grasses. Italian rye-grass is used, as most of it will disappear after the first year, and will allow permanent plants room to develop.

* The prices quoted are calculated on price lists for 1908, a year of high prices. Prices are subject to considerable variation, and this mixture might usually be made up for 21*s.*–23*s.*

(3.) The quantity of the larger permanent grasses is much less than is usually recommended. A careful examination of a number of recently sown pastures has shown that when rye-grass is included in the mixture it is unnecessary to sow much seed of the slower growing grasses.

(4.) Timothy and the two meadow-grasses have been used in greater quantity than other permanent grasses, because of their cheapness. When the price per million is considered, these grasses and white clover form the cheapest pasture plants. In moist seasons all four plants grow well, but in dry summers timothy and rough-stalked meadow grass are poor growers. In districts where the summer rainfall is low, the quantities of these two grasses recommended in the above mixture should be reduced by one-half.

(5.) Deep-rooted plants—burnet, chicory and yarrow—are useful in opening up the soil, admitting air, and promoting a healthy development of the roots of other plants.

The principles kept in view in preparing the above list of seeds, were three in number. Firstly, the necessity of covering the soil quickly and uniformly. Secondly, the necessity of preserving a good "plant" of white clover, which, with the assistance of suitable manures, may be made to occupy a large portion of the soil during the second stage of the pasture's existence. Thirdly, the introduction into the pasture of a large number of good plants, some of them, like cocksfoot, timothy, and meadow fescue, especially useful in the second stage, and all more or less desirable in the mixed herbage of a permanent pasture.

The seeds-mixture is based upon the observation of the behaviour of pasture plants in a limited number of experiments. It cannot be called "scientific," it has not been tried and tested under different conditions, and its real purpose is to suggest a mixture for the use of those who are beginning the study of pasture plants and pastures. No great importance need be attached to the exact quantities of timothy, cocksfoot, &c., recommended. The quantities of rye-grass and clover specified are the smallest quantities that could be depended upon to produce a cover, but in the other cases, the object has been to introduce a sufficient stock of each of the plants into the pasture, and they are not meant to occupy much of the surface until the third or fourth year.

As the mixture is intended for use on poor clay soils, and as such soils are generally very deficient in phosphates, it will be desirable to use basic slag liberally on the young pasture. If the roots have been treated as above recommended, from 7–10 cwt. of basic slag should be applied to

the seeds in the autumn after the corn crop has been cut; but if the land has been manured immediately before sowing seeds, the application of basic slag to the young pasture may be delayed for a year.

Mixture for light and medium soils.—If a pasture on a clay soil is properly managed, white clover will cover the surface pretty uniformly about the third or fourth year after sowing, and it will often grow well on light loam soils in moist seasons; but under ordinary circumtances, white clover cannot be expected to cover nearly so large a proportion of the surface of light as of heavy soils. Chiefly for this reason, it is desirable to sow rather more grass on light soils than has been recommended in the above table, so that the place of clover may be taken by cocksfoot, the meadow grasses, hard fescue, and crested dogstail, during the second stage of the pasture's development.

For sowing down permanent pastures on light and medium soils in a district having an average rainfall of 25″–30″, the following mixture is suggested :—

——	Percentage Composition.	Per Acre.		
		Approximate Number of Germinating Seeds in Thousands.	Approximate Weight.	Approximate Cost.*
			lb.	*s.* *d.*
Top Grasses—				
Perennial rye-grass	10·0	1,500	7	2 4
Cocksfoot	6·6	1,000	2½	2 11
Timothy	5·0	750	½	0 3
Italian ryegrass	3·3	500	2	0 8
Meadow foxtail	1·6	250	½	0 11
Meadow fescue	1·6	250	1	0 11
Bottom Grasses—				
Hard fescue	10·0	1,500	2¾	2 0
Rough-stalked meadow grass	10·0	1,500	¾	1 2
Smooth-stalked meadow grass	10·0	1,500	1	1 3
Crested dogstail	3·3	500	½	0 10
Golden oat grass	1·6	250	⅕	0 8
Leguminous Plants—				
White clover	20·0	3,000	4¼	4 5
Alsyke clover	5·0	750	1	1 1
Perennial red clover	3·3	500	2¼	3 2
Lucerne	1·6	250	1¼	1 3
Medick	1·6	250	¾	0 4
Miscellaneous Plants—				
Yarrow	3·3	500	⅙	1 0
Chicory	1·6	250	1	1 0
Total		15,000	29⅓	26 2

* The footnote to page 4 applies equally here.

It is impossible to discuss here the variations that should be made in the above mixture in different districts, but it may be pointed out that rough-stalked meadow grass is a poor plant on a hot dry soil, and that lucerne, which is particularly useful under these conditions, is not adapted for northern pastures. In the south, on soils well supplied with lime, 5–10 lb. of unmilled common sainfoin may be included in the above mixture. Unmilled sainfoin often contains burnet as an impurity, and if burnet can be purchased cheaply in this way it may also be sown with advantage.

The mixture recommended for clay soils was made up in the usual way by taking a certain number of pounds of each seed; in the foregoing table a second method of constructing the mixture is shown. The approximate number of germinating seeds to be sown has been fixed upon, and the figures in the other columns have then been calculated.

The "pound" is altogether unsuitable when dealing with seeds. Not only does the number of seeds per pound vary widely, but the number of plants produced by a pound of different samples of the same seed is liable to great fluctuation. Farmers are therefore recommended to consider "number" and not "weight" when sowing, and to aim at a certain number of plants of rye-grass, &c., not at a certain number of pounds of seed. The seed merchant should be asked to guarantee the purity and germinating power of his seeds, and then the approximate number of plants that a pound will produce is readily ascertained. It is not intended that the farmer should attempt by exact calculation and careful weighing to sow the precise numbers given in the above table. This would of course be impossible, and if possible, the attempt would be useless; for as has already been explained, soil, season, and manuring so affect the young pasture that it usually bears no close relationship to the particular mixture used in sowing, and a few thousands of seeds more or less will make but little difference. Why then, it may be asked, should one trouble about the percentage composition of the mixture? The reason for making some attempt at precision is this:—while soil and climate affect the character of the pasture produced by any particular seeds-mixture, the final result is in part due to the influence of one plant upon another. Rye-grass will affect cocksfoot, for example, and red clover will affect white clover. In order, therefore, that we may be able to explain the final results fully, we must know approximately the composition of the seeds-mixture, and a mere record of the number of pounds sown will not help us much because of the variation in the quality of seeds. One reason why agriculturists know so little about seeds-mixtures, is that they have no experience to guide them. Some mixtures have been sown and have given good results, other mixtures have been sown and have failed.

Very rarely can the causes of success or failure be traced. The careful seedsman who knows the exact composition of the seeds-mixture is unable to follow its history after it passes into the hands of the farmer; the farmer who knows all about the effects of season and manure, pays no heed to the composition of the mixture, and thus he is no more able to explain success or failure than the seedsman. Until agriculturists give more attention to the compounding of the seeds-mixture than they now do we shall be without that practical experience which is necessary to success in this, as in all departments of farming.

Six to nine months after sowing the seeds, light soils should receive from 3 to 5 cwt. of superphosphate, and from 2 to 4 cwt. of kainit per acre; and these manures, in quantities varying with the condition of the herbage, must be repeated at intervals of from one to three years until the pasture becomes established. Nitrogenous manures may also be employed with advantage under certain conditions, but to use them successfully on pastures, a farmer must be well acquainted with their properties, and their general use is not to be recommended. A dressing of from 7 to 10 tons of farmyard manure, two or three years after sowing down a pasture, would usually prove very beneficial.

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BOARD OF AGRICULTURE AND FISHERIES.

The Cultivation of Mangolds.

In Great Britain the mangold (*Beta vulgaris*) is chiefly cultivated in the southern and midland counties of England, since it requires a warm, somewhat dry, climate. The mangold grows best upon rich loams or upon such peaty soils as are found in the fens; but in a suitable climate it is not very exacting as regards soil, and good crops may be grown upon light loams or upon stiff clays. In general it succeeds better upon stiff than upon light land. Under favourable conditions the mangold crop is one of the most valuable that a farmer can grow. As a food for dairy cows, for ewes after lambing, and even for pigs and poultry, mangolds are of great value, and, as they store well, they provide an admirable crop for summer use. Pulped and mixed with chaff, and fed in conjunction with cake and meal they form an excellent winter ration for keeping up or increasing the milk yield. The ration fed may vary widely with the season of the year and with the quantity available. For dairy cows from $\frac{1}{2}$ to $\frac{3}{4}$ cwt. per head per day would be an ordinary allowance, and full-grown fattening cattle would usually receive from $\frac{3}{4}$ cwt. to $1\frac{1}{4}$ cwt. in the Eastern counties.

The varieties commonly grown are the white-fleshed or Yellow mangolds, the yellow-fleshed, Golden or Orange mangolds, and the pink-fleshed, Red mangolds, these occurring in sub-varieties described according to shape, as Globe, Intermediate, Tankard and Long varieties. The mangold is essentially a food rich in sugar, the total dry matter averaging about 12 per cent., of which nearly two-thirds will consist of sugar. The composition, however, varies considerably. Yellow Globe mangolds average about 10·5 per cent. dry matter, while the Golden Globe, Golden Tankard and Long Red varieties may contain from 12·5 to 13 per cent. Small bulbs on the average are somewhat richer in dry matter than large specimens. Certain changes take place in storing which render the roots more suitable as a food for stock, and they are therefore usually kept over winter until the early months of the year. They may, however, be fed to stock from October or November onwards—though not so suitable at this period—until the end of the following summer.

Preparing the Seed-bed.

As one of the root or fallow crops, mangolds follow a corn crop. They allow the ground to be thoroughly cultivated and cleaned, and as they are deep rooting they materially assist

in getting the land into good "heart" for the succeeding corn crop. If the land is at all foul with weeds autumn cultivation should be directed to cleaning, after which long manure should be carted on during dry weather and the land ploughed deeply for the winter. In some cases, however, the land is laid up in ridges. Dung may, if desirable, be applied in spring, but should then be in the "short" or rotten condition. For seeding purposes a deep, mellow tilth is required, and to this end spring cultivation takes the form of ploughing, scuffling or cultivating, and harrowing, all perennial weeds being drawn out. The result should be that a fine seed bed is prepared ; but care must be taken not to over-dry the soil, and if the soil is clean, it is desirable to prepare the ridges a fortnight or more before sowing the seed. If dung is to be applied in spring (1) the land may be ridged, and the dung spread, after which the ridges must be split back, or (2) when sowing is to take place on the flat the dung may be ploughed in by the ordinary plough. Spring manuring is not well adapted for dry districts, however, and if mangolds are sown on the flat, the dung should have been ploughed down during the previous autumn or winter.

Manuring.

This crop is much influenced in yield by the character of the manuring.

As in the case of most crops so in this : the manuring may be conducted along three main lines. The grower may depend on farmyard manure alone, or on artificials alone, or on a combination of these two classes. The selection of the particular system of manuring will depend on the particular circumstances of the farm. If farmyard manure is abundant and of good quality, it may be most profitable to rely on it alone. On a farm where much straw is sold, or where the dung is chiefly used on the wheat or meadows, the mangold crop must be chiefly treated with artificials. But in the majority of cases the natural fertilizer is not so abundant, or of such high quality, as to be alone depended on, nor, on the other hand, is it so scarce as to be altogether ignored, and the result is that the mangold crop receives dung supplemented by artificials.

During the past fifteen years or so a large number of manurial experiments have been conducted on the manuring of this crop by agricultural colleges and societies, and from the results thus obtained it is possible to draw conclusions which can be applied with confidence to average conditions. It is, in fact, in this way that rules are framed for general guidance, and it is on such general rules that the bulk of the manuring is performed. But a study of the figures obtained from experiments shows conclusively that the acceptance of general principles will often lead to

most unsatisfactory results, and no farmer can be sure that he is getting the most out of his land who has not determined its manurial requirements by means of some simple and well-conceived field experiments.

The Use of Farmyard Manure Alone.—If land is in good "heart," and especially if it is the custom to top-dress the straw crop that succeeds mangolds, it is often possible to grow nearly a full crop of the latter by using about 20 tons of dung without any addition. As a rule, however, it will pay better to use less dung for this crop, and to employ the surplus on some other crop of the farm, supplementing the dung by means of some artificial dressing.

The Use of Artificial Manure Alone.—Although very large crops of mangolds can be grown without any farmyard manure, this course would be justifiable only under very exceptional circumstances. The system might, however, be warranted on outlying fields, or in the case of a farm favourably situated for the sale of straw, but in any case the crop succeeding the mangolds (unless it were barley) would seldom give a satisfactory yield without the direct use on it of a considerable amount of artificials. Speaking generally, if artificials are alone depended on for the mangolds they should be ample in amount and should contain all of the three important substances : nitrogen, phosphates, and potash. Of these, most attention should be given to the nitrogen, the bulk of which should be derived from nitrate of soda. This manure, in the great majority of cases, acts much better than sulphate of ammonia on the crop under consideration. It is only in districts where the rainfall is heavy that the latter manure may largely replace the nitrate. Organic nitrogen, in the form of rape dust, blood meal, fish meal, dissolved bones, &c., often acts well in the absence of dung, and if these manures can be obtained at a reasonable price they may form a proportion of the mixture, and especially on the lighter classes of soil. Without dung nitrate of soda may be used up to 3 cwt. per acre, though 2 cwt. will usually suffice, or half of this dressing may be replaced by a corresponding outlay on one or other or several of the manures just mentioned.

In the majority of cases superphosphate will furnish the most suitable form of phosphoric acid, 5 or 6 cwt. per acre being as much as will usually prove profitable. Basic slag does not generally prove a satisfactory substitute for superphosphate for use on this crop, at least when applied at the time of sowing the seed, though 3 or 4 cwt. per acre put on in early spring may, on heavy land, replace 2 or 3 cwt. of superphosphate. Dissolved bones, as has already been indicated, may to some extent be used, but bone meal is not to be recommended.

Potash has often proved to be the constituent that determines the success of this crop, and every farmer should take steps to ascertain how his mangolds react to its use. Of the three forms generally available—kainit, sulphate of potash, and muriate or chloride of potash—the preference is generally to be given to the first on account of the common salt which it contains ; 5 cwt. per acre would be a suitable dressing in the absence of dung. Much has been written about the effects of common salt on the mangold crop, and there can be no doubt that in the absence of kainit its use, at the rate of 3 to 4 cwt. per acre, will often be found to pay, especially on the lighter classes of land.

The Use of Dung Supplemented by Artificials.—This is the usual and best combination in which to supply fertilizing materials to the mangold crop. The amount of dung which should be used per acre must depend chiefly on the aggregate amount at the farmer's disposal. Speaking generally, and having regard to practical convenience, 10 tons per acre may be taken as the minimum, while little is to be gained by exceeding 18 tons. Of the supplementary artificials nitrate of soda is by far the most important, and 1 to 1½ cwt. per acre may be put as the normal allowance. Phosphates are of less importance, and 3 to 4 cwt. per acre of superphosphate will usually suffice. Although dung holds much potash, the addition of this substance in the form of 2 or 3 cwt. of kainit will usually prove profitable, and it should not be omitted unless previous experience has shown it to be unnecessary. Here, as where artificials alone are used, salt may be given at the rate of 2 or 3 cwt. per acre.

In some parts of the country it is the custom to top-dress the mangold crop during June or July with ½ to 1½ cwt. per acre of nitrate of soda, and the practice may be recommended if the crop appears to require assistance. Where this course is followed some reduction should take place in the amount put on at the time of sowing the seed.

Seed and Sowing.

Mangold "seeds" as they occur in commerce consist of two or three true seeds embedded in a woody capsule, and this explains why several plants come up in a group, rendering careful thinning so necessary. The germinating capacity of mangold seed should be not less than 120, while it may be 180 or over.

Mangolds are usually sown between the beginning of April and the middle of May. Except in those districts which are exposed to late frosts, or in which mangolds are liable to "bolt," the earlier in April the sowing is done, the better are the prospects of the crop. Three to 6 or 10 pounds of seed are sown per acre, according to the system of sowing, the

quantity being least when dibbled. In most cases sowing on the ridge is to be recommended, but in dry districts or on light soils the "flat" system is preferable. Seed may be drilled in the first case by means of small drills covering two ridges at a time, with rollers before and behind the drill coulters, while on the flat an ordinary corn drill is employed. For small areas dibbling may be resorted to. The rows are usually from 26 ins. to 29 ins. apart when mangolds are sown upon the ridge, and from 22 ins. to 26 ins. apart when sown on the flat. In dibbling, 1 ft. apart in the rows is about the distance for sowing, two or three seeds being placed in each hole. Mangold seed should not be sown deeper than $\frac{1}{2}$ to 1 in. A roller should follow the drill when seed is drilled on the flat, and as a firm seed bed is necessary ridges should be rolled after sowing if the soil is at all loose or open.

Subsequent Treatment.

As soon as the young plants are well up the horse-hoe should be set to work, and all weeds must be kept down between the rows by repeating the hoeing until the wide-spreading leaves or the growth of the roots would render further treatment in this way harmful. Hand-hoeing also must be sufficiently frequent to keep down weeds between the plants in the rows. "Singling" commences as soon as the plants are well established, and usually from six weeks to two months after sowing. The plants are set out 12 to 14 ins. apart, the lesser distance when the rows are over 2 ft. apart. Some skill is necessary to carry out this operation, since several plants may grow from one "seed," and a second singling may be requisite.

Top-dressing the crop once with nitrate of soda is frequently practised when the crop is about two months old (*see* p. 4), or two half-dressings may be given at a few weeks interval. A portion of the common salt may also be given as a top-dressing where this fertilizer is employed.

Pulling and Storing.

Pulling.—Harvesting of the mangold crop takes place during October or early November after yellowing of the leaves. The quantity to be lifted may vary from 15 to 50 tons per acre; from 20 to 30 tons is an ordinary crop. Mangolds are pulled up by hand, the leaves are *twisted off* to minimise "bleeding," and the roots are then thrown into heaps and covered with the removed leaves.

Storing.—Being very liable to injury by frost, mangolds must be carefully covered. They may be stored in large quantities in pits or clamps. The roots are first arranged

in a long triangular prism about 6 ft. wide at the base. This "clamp" is then covered thinly with straw or bracken, this in turn being covered with 9 inches of soil dug from all round the clamp, which is thus left standing on ground surrounded by a wide trench. The ridge layer of soil is best put on a week or so later in order to permit complete ventilation. Stored in such a manner mangolds will remain in excellent condition throughout the winter, during which time the roots will "ripen."

4, Whitehall Place, London, S.W.,
March, 1907.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained, free of charge, and post free, on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 170.

BOARD OF AGRICULTURE AND FISHERIES.

The Uses of Lime.

The practice of liming or chalking the soil is one of the oldest and most widely-spread operations of British agriculture ; unfortunately for many districts, it is a custom that is perhaps less observed at the present time than at any other period since farming became an organized industry. Until about forty years ago lime was much more extensively used in agricultural practice than it is to-day.

There are several reasons why the practice of liming has fallen so much into disuse. In the main, however, it may be said to be due to (1) increased cost of labour ; (2) the increased use of artificial manures ; and (3) the reduction in the value of corn crops. Several common manures contain lime, but a clear distinction must be drawn between free lime, as it exists in quicklime or slaked lime, and lime combined with an acid, as in bones, where it is combined with phosphoric acid, or in gypsum, where it is combined with sulphuric acid. What is necessary for the soil is not merely the chemical substance lime, but a base, *i.e.*, something capable of combining with the acids which are naturally or artificially produced in the soil. The desired base is found in quicklime or in slaked lime. Chalk and all natural limestones contain lime combined with carbonic acid, which, however, is so weak an acid that it is easily turned out and does not interfere with the basic properties of the lime, whereas in bones or gypsum the lime is already completely saturated with strong acids, and in superphosphate there is even an excess of acid, which demands more lime from the soil to neutralize it.

Quicklime and slaked lime when applied to the soil quickly revert to the state of carbonate of lime or chalk in which they existed before they were "burnt" in the kiln, and it is this substance, carbonate of lime, that is denoted in referring to "lime" in the soil. The superiority of burnt lime over chalk or limestone for application to the soil lies simply in the fact that it falls naturally into a fine state of division, some of it also passing into solution, so that it is more easily disseminated throughout the soil and acts with greater rapidity and in smaller quantities.

To return, however, to the point in question, only freshly burnt lime (quicklime), slaked lime, chalk, limestone, marl, basic superphosphate and basic slag contain "lime" in the farmer's sense, *i.e.*, in the form of a base capable of neutralizing acids ; in bones, in superphosphate, and in gypsum the lime is combined with acids, and is no longer capable of acting as a base.

The Uses of Lime.

Besides its indirect value in neutralizing acids in the soil lime has several other uses, all of which are of great importance to the farmer. These uses may be given as follows :—

1.—Lime improves the nature of the soil by coagulating the finest particles of clay and rendering the land more open and friable. Drainage then goes on more readily, while the land is warmer, and is more easily worked to a good tilth. It is difficult to exaggerate the value of this action of lime on the heavier soils ; it is frequently possible to secure a seed bed when the unlimed land is still too wet to work, and the character of the crop may depend as much upon securing a good tilth as upon manuring.

2.—Lime is an essential plant food, and without it soils cannot produce good crops. Soils are generally considered to be deficient in lime when they contain less than from ·5 to 1 per cent. Some soils, however, which are provided with a considerable amount of organic matter, may respond to lime although they contain much more than these amounts.

3.—The insoluble reserves of nitrogenous and potassic material in the soil are brought into action and rendered available for the plant by the presence of lime. The following table shows the result of applying in January, 1903, 2,000 lb. per acre of ground quicklime to some of the grass plots at Rothamsted, where there was a good deal of residue from past manuring locked up in the soil :—

Year.	Plot 7.		Plot 9.	
	Yield with mineral manures only.		Yield with complete artificial manures.	
	Unlimed.	Limed.	Unlimed.	Limed.
	Cwt.	Cwt.	Cwt.	Cwt.
1903	49·5	51·9	50·1	60·5
1904	61·9	61·8	63·7	69·8
1905	44·3	47·2	36·9	52·2
1906	34·4	41·4	39·0	50·0

4.—The leguminous crops usually cultivated on the farm flourish better when a good supply of lime is present in the soil. Clover, in particular, is very intolerant of acid soil conditions, and is much more subject to clover sickness when lime is deficient.

5.—It seems to be established that the soil organism (*Azotobacter*) which fixes nitrogen without the aid of leguminous plants, and is probably a great factor in the gain of fertility when land is laid down to grass, cannot develop properly unless a good supply of carbonate of lime is present.

6.—Lime in one form or another is the best remedy for finger-and-toe disease* in turnips and swedes. These root crops are always liable to the disease when the soil is deficient in lime.

The fertility of many farms to-day is undoubtedly due to the liming and chalking that was done by the farmers of the eighteenth and earlier centuries ; they, indeed, made the soil, for it is through their labours that it remains in profitable cultivation at the present time. Owing to the very large amounts of chalk and lime which were then applied, it has been possible for later generations to live upon the capital thus accumulated and dispense with any expenditure of their own in this direction. But this spending process cannot continue indefinitely, for natural causes alone—*e.g.*, the percolation of rainwater—are steadily removing the lime in the surface soil ; for example, the Rothamsted soil, which at the beginning of the nineteenth century must have contained something like a hundred tons of chalk per acre, has now less than fifty, and many other soils which started with a smaller initial stock are beginning to run dangerously short. In many parts of the country there is evidence that the land, especially on the heavier soils, is in need of liming, and though it might not be wise to return to the old heavy dressings of six to ten tons to the acre, a much smaller quantity, half a ton or so per acre, could be profitably applied at least once in the course of each rotation.

The Influence of Manures on Lime in the Soil.

The various classes of manures used in farming have some bearing upon the rate at which lime is washed out, and this question has been investigated at Rothamsted. The results of the investigations may be given briefly as follows :—

(1) Superphosphate, sulphate of potash, kainit, and kindred manures do not increase the loss to any appreciable extent.

(2) Farmyard manure and probably all organic manures diminish the loss of carbonate of lime.

(3) Nitrate of soda also diminishes the loss.

(4) Sulphate of ammonia increases the loss, removing about half its own weight of lime or nearly its own weight of chalk.

Lime sinks in the soil of grass land from purely mechanical reasons ; in arable land this sinking is less marked, but the lime is subject to a greater wastage by solution in the rain water percolating through the soil.

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* *See* Leaflet No. 77 (*Finger-and-Toe in Turnips*).

The Classes of Lime.

In nature lime generally occurs as carbonate of lime, in the form of chalk, limestone, marble, marl, and other substances. Perhaps one-sixth part of the rocks composing the earth's crust consists of this material.

Those materials containing lime which are of any agricultural importance may be tabulated as follows :—

1. *Bases*, capable of neutralizing acids.
   Quicklime, burnt lime, lime-shells, caustic lime = lime.
   Slaked lime = lime and water.
   Chalk, limestone, marl, old mortar, &c. = lime and carbonic acid.
   Basic slag = lime and phosphoric acid (lime in excess).
   Basic superphosphate = lime and phosphoric acid (lime in excess).
2. *Neutral salts*, in which the lime is already neutralized by a strong acid. Compounds of this class occur in :—
   Gypsum = lime and sulphuric acid.
   Bones and mineral phosphates = lime and phosphoric acid.
3. *Acid salts*, which contain more acid than the lime can neutralize. Compounds of this class occur in :—
   Superphosphate } lime and phosphoric acid (phosphoric acid in excess).
   Dissolved bones }

Quicklime and Slaked Lime.—The most common form in which lime is purchased by farmers is that known as burnt lime, lime-shells, quicklime or caustic lime. It is obtained by burning either chalk or limestone in a lime-kiln. Quicklime greedily absorbs and combines with water, forming slaked lime, while it also readily takes up carbonic acid gas from the atmosphere, forming carbonate of lime which is similar in composition to pure chalk or limestone. For this reason quicklime should be exposed as little as possible to rain and to the atmosphere, but should be applied to the land without delay.

Where coal is cheap the price of good lime at the lime-kiln averages perhaps 9*s.* per ton. A guarantee should be obtained that it contains not less than 85 per cent. of quicklime and not more than 4 per cent. of magnesia.

Ground Lime.—This consists of burnt lime (quicklime) which has been ground to a fine powder. It should be similar in quality to quicklime, but is often impure and contains less lime than ordinary quicklime.

Ground lime is more expensive than lime shells owing to the cost of grinding, which may amount to 6*s.* per ton, while an additional 3*s.* must be added for sacks. A good sample therefore may cost about 18*s.* a ton at the lime-kiln.

Chalk.—This substance is really a soft limestone, and when the flints are removed is usually a very pure form of carbonate of lime. When fairly pure it will contain about half its weight of lime. When treated with a ·1 per cent. solution of citric acid (which is approximately equal to the acid in soil water) the lime in chalk is about half as soluble as the lime in caustic lime.

Marls.—These are mixtures of earthy matter and carbonate of lime, but their consideration is beyond the scope of this leaflet.

Gypsum.—This compound of sulphuric acid and lime is seldom employed as a separate manure, but it forms about two-fifths of the weight of ordinary superphosphate.

Gas Lime.—This form of lime is a by-product in the manufacture of coal gas, for which lime is employed as a purifying agent. It consists of slaked lime more or less saturated with compounds of sulphur ; it is liable to considerable variation in composition, and often has but little basic property left in it and so cannot take the place of lime or chalk. It contains small proportions of certain compounds of sulphur which are virulent plant poisons, this fact necessitating great care in its use. It is unprofitable to use it at considerable distances from a town, or where high railway rates prevail, as the percentage of lime present is usually small.

Basic Slag.—Basic slag is a by-product in the manufacture of steel, and is very largely employed as a phosphatic manure. It usually contains about 45 per cent. of lime, and a considerable proportion of this is available as a base capable of neutralizing acids in the soil, though probably not more than 2 to 5 per cent. is in the form of "free" or "caustic" lime. The fact that the lime present is available for counteracting acidity in the soil renders basic slag of very considerable value on soils deficient in lime.

The Application of Lime.

The most common method of liming is to put quicklime (lime shells) on the land in small heaps and allow it to slake naturally, or to slake it with water from a water-cart. It may then be spread with a shovel and harrowed in at once. Lime shells may also be slaked as is done by a mason's labourer, reducing them to a fine powder. They are spread in layers a foot deep, one above the other, each layer receiving about 6 cwt. of water per ton of lime, or rather less water if the lime is inferior. The heap is then covered with about half a ton of sand for each ton of lime. The lime in such a heap will keep for a considerable time. Before using, the heap may be screened through a three-eighth-inch gauge locking screen. Lime thus slaked should be in a fine

powdery condition, and the sand mixed with it renders the spreading a somewhat less dusty process. Lime when over-slaked becomes pasty, after which even distribution in the soil is impossible. The lime may be carted to the land and distributed by hand direct from the carts, but this method must be thoroughly carried out. It is much better, however, especially when small quantities are being applied, to adopt the American plan, *i.e.*, to use a suitable manure distributor, to which old sacking has been attached at the sides and behind. This trails along the ground, insures better distribution, and prevents much of the discomfort that is otherwise caused by the blowing about of the fine lime. Glasses for the eyes and protective devices for the nostrils and mouth are also used by men who do this work.

Since lime is used for many purposes the proper quantity to apply varies widely. Common dressings are from 2 to 3 tons of quicklime at intervals of from six to ten years. Smaller dressings of about 1 ton per acre once in four or five years are now becoming common. Considerably larger quantities than the above may be used in the treatment of newly-reclaimed land rich in organic matter and plant food.

Ground Lime.—This is usually applied by means of a manure distributor at the rate of from 5 to 30 cwt. per acre.

Gas Lime.—Owing to the presence of certain poisonous compounds already mentioned, gas lime should be carefully spread on the land six or eight weeks before ploughing. It is best applied to lea in the autumn or early winter, at the rate of from 2 to 4 tons per acre. On most soils the oat crop which follows will be considerably benefited.

Chalk.—If chalk be reduced by grinding to as fine a condition as caustic lime, it will be sufficient to apply 1 ton per acre of ground chalk instead of 10 cwt. per acre of ground lime. The ground chalk would usually be both less costly than ground lime, and more convenient to apply. At the same time it would have a less rapid action in the destruction of vegetable matter in the soil.

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Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 10 leaflets dealing with Manures and Feeding Stuffs may be obtained from the same address, price 1d., post free.

BOARD OF AGRICULTURE AND FISHERIES.

Violet Root-Rot (*Rhizoctonia violacea*, Tul.)

This disease was recognised and described nearly two hundred years ago as the cause of serious injury to the saffron industry in France. It was at that time also noted that the disease attacked the roots of many other kinds of plants, both wild and cultivated. From this period it has not only continued its ravages, but has attacked in turn almost every new plant introduced to cultivation. It does not, however, attack cereals.

Plants Attacked.

In this country *Rhizoctonia* has a special predilection for lucerne; clover, carrots, beet, mangold, and potatoes sometimes also suffer severely, and most frequently when they follow lucerne, which appears to attract the stray mycelium of the fungus present in the soil. The mycelium increases enormously in quantity on the root of this plant, and a large stock remains in the soil in a vigorous condition ready to attack any suitable host. If the following crop happens to be a cereal, which the fungus cannot feed upon, it attacks weeds of various kinds, and thus tides over the period until a crop suitable to its requirements is planted, when a fresh stock of mycelium is again left in the soil.

Description and Appearance of Plants Infested.

The disease is readily recognised by the bright colour of the mycelium of the fungus, which varies from rose, with a tinge of purple, to a deep brownish purple when old. The mycelium at first spreads as a delicate, much-branched network over the surface of the root or tuber, and finally forms dense patches, or covers the entire surface with a compact felt. As a rule the fungus confines its attacks to underground parts of the plant, but when the weather is continuously damp and dull the mycelium sometimes extends up the stem, and even passes on to the leaves and fruit.

The first sign of disease is the drooping and yellowing of the foliage; the presence of violet mycelium on the surface of a carefully removed root proves the fact.

Sources of Infection.

So far as at present known the fungus does not form fruit, its only mode of reproduction being vegetative by means of mycelium.

The way in which the fungus spreads in the soil and keeps its hold can readily be seen. When a root or tuber has become superficially coated with a felt of mycelium, sclerotia or concentrated masses of mycelium of two distinct kinds of structure, and having different uses, are formed. Some sclerotia are of considerable size, varying from that of a pea to a hazel nut; these become free from the root when

fully formed, and remain in the soil as centres of future infection. Other sclerotia, rarely exceeding the size of an ordinary pin's head, are usually produced in considerable numbers under the felt of mycelium, and in close contact with the root or tuber, to which they remain firmly attached, and are removed along with it. If such infected roots or tubers are eaten by some animal, the minute, compact sclerotia are not injured by passing through the digestive system, and are in this way often transported to new localities. In like manner new districts are often infected by means of minute sclerotia attached to potato tubers, carrots, &c. In some instances beans and peas are attacked while yet in the pod, and minute sclerotia are formed in the skin of the seed.

The disease usually spreads from a point of infection equally on every side, the mycelium gradually spreading through the soil from diseased to healthy plants.

Injury Caused by the Disease.

The amount of injury caused by the fungus varies to a great extent on different plants. In the case of *beet* and *carrots*, the mycelium soon enters the fleshy root and destroys it. In *lucerne* and *clover* the active rootlets are killed, whereas in the case of *potatoes* the entire surface of the tuber may become covered with the fungus without sustaining injury, the mycelium being unable to penetrate the skin except through a wound. When once it is through the skin, however, the tuber is soon reduced to a pulp.

Prevention and Remedy.

1.—The fungus can only develop in the presence of an acid, and can therefore be held in check by the free use of lime.

2.—Good drainage and the prevention of sourness of the soil are essential features in combating the disease.

3.—Weeds should be rigorously suppressed, for they furnish the main supply of food for the fungus when a cereal crop is present.

4.—Care must be taken not to introduce the disease by means of small sclerotia adhering to seeds or tubers.

5.—Seed obtained from dry, elevated districts should be selected.

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Leaflet No. 172.

BOARD OF AGRICULTURE AND FISHERIES.

Bare Fallows.

Historical.

The practice of taking a bare fallow as a preparation for wheat was at one time almost a universal custom in farming. It was said to have been introduced into these islands by the Romans, and in mediæval times the usual rotation appears to have consisted of wheat, barley, fallow, with beans instead of barley on the stronger lands. In Scotland, where up to the eighteenth century it was the custom to grow corn crops repeatedly and then let the land lie in grass for a few years, the introduction of a bare summer's fallow, after the ley was broken up and before the wheat was sown, was one of the earliest improvements in the traditional system of farming. The thorough cleaning which the land received, and the marked improvement in the tilth which was effected, were strong arguments in favour of the practice; furthermore, experience amply demonstrated that better crops of wheat could be secured after a bare fallow than after a previous corn crop or a recently ploughed lea. The early theorists concluded that some fertilizing principles were absorbed from the atmosphere during the summer's exposure to sun and air, and, indeed, it became patent that the more thoroughly the soil was stirred and pulverized by the cultivations the greater was the benefit resulting from the fallow.

But towards the close of the eighteenth century the custom had begun to decline; green crops, and turnips in particular, had become part of the routine of farming, and the Norfolk husbandry, with its four-course system of turnips, barley, clover, wheat, was spreading from the Eastern Counties all over Great Britain.

The more advanced farmers perceived the importance of keeping the land under crop; by growing turnips it was possible to obtain all the advantages, in the shape of the cultivation and the stirring of the soil, which result from a bare fallow; at the same time, food was provided for the stock, and a much better kind of dung was made than when the straw was merely trampled down to get it into a state fit to go back upon the land. The writings of Arthur Young,

who was Secretary to the then Board of Agriculture, in the early years of the nineteenth century, were unceasingly directed against bare fallows; and his influence, combined with the numerous enclosures and the high prices prevailing during the Napoleonic wars, did much for the spread of turnip culture. The strong lands and the clays were still the difficulty; on them it was often a costly and even an impossible operation to secure a good plant of turnips, but it became more and more a mark of careless farming to rest content with a bare fallow. Mecchi showed that the strongest Essex clays could be made to grow turnips, and with the spread of mangel cultivation it became possible to put even the most stubborn soils in the South and East of England under roots. The bare fallow still survived as an occasional operation once in seven or eight years, and many clay-land farmers maintained that it was a profitable operation, the benefit of which was felt for several years. Latterly, with the fall in corn prices and diminished rents, the acreage under bare fallow has again showed a tendency to increase. For instance, in Essex the bare fallow in 1866 amounted to 11·4 per cent. of the land under corn; in 1904 it was 16 per cent.; in Suffolk the bare fallow has actually increased, despite the diminution in the area of arable land, rising from 25,000 acres in 1866 to 30,400 acres in 1904.

Beneficial Effects of Bare Fallows.

A bare fallow may exert a beneficial effect on the land in three ways :—

1.—*By cleaning the land of weeds;*
2.—*By improving the texture of the soil; and*
3.—*By increasing its fertility.*

1.—A bare fallow is generally taken after a stubble crop, the prime object being to get as many weed seeds as possible to germinate. A first ploughing in autumn will be followed by a cross-ploughing in the spring and two other ploughings in the summer. Sometimes the first ploughing is left until the spring corn has been sown, and is followed by two or even four ploughings during the summer. The harrow is used after each ploughing to collect the weeds, and many farmers roll the land to reduce the clods and promote the germination of the weeds. But on many soils it is desirable to avoid getting too fine a tilth, lest heavy rains cause the land to run together and the surface to set to a hard crust. To this danger the heavy loams and clays with an admixture of fine sand are more liable than the clays proper.

The continued cultivations and repeated draggings will rid the land of couch; at the same time annual weeds are germinated, and destroyed by the next ploughing.

2.—It may be said, however, that with reasonable farming land should never get so foul as to require a bare fallow to clean it, and it is found among the clay-land farmers that their chief justification for a bare fallow lies in the great improvement in the texture of the soil that results. A clay soil is in the main composed of very fine particles, and the finer the particles are the "heavier" and the more tenacious is the clay. Coarse-grained material like sand does not bind together when dry, but the more fine-grained it becomes the more sticky will it be when wet, and the firmer will it set when dry. To a certain extent these very fine particles in an ordinary clay soil are loosely bound together into little groups which behave like single larger particles. If, however, the clay is knocked about when it is wet the groups are broken up into their constituent fine particles, thus increasing both its holding power for water and its tendency to dry to a hard clod. This is seen to the fullest extent when clay is deliberately "puddled," in which state the particles making up the clay are all separate and able to move independently. Exposure to the weather, on the contrary, freezings and thawings, alternate dryings and wettings, unite the particles again and lighten the texture of the soil. With the best of management the texture of heavy clay land tends to deteriorate under cultivation, and the rest it gets by lying under grass for a year or two, or from a summer's fallow, is necessary from time to time to get the soil back into a good working condition. The improvement persists for three or four years and forms the main reason for taking a bare fallow nowadays; for good crops, particularly of roots, depend more on the tilth of the seed-bed than on any other single factor in farming.

3.—Many have been the theories as to whether land gains or loses fertility through a summer's fallow. Thaer, who was an authority about the beginning of the eighteenth century, wrote: "There is no doubt that the fallow absorbs or attracts the fertilizing properties of the atmosphere." Arthur Young, on the contrary, with his aversion to bare fallows, wrote about the same time: "The quantity of gas or vapour that is hourly exhaling from a fallow field after rain or every fresh ploughing is improvidently lost, and argues a want of economy that is truly reprehensible." But experience was against Arthur Young; the practical farmer knew that cultivation by itself made the land better able to support a crop; this was the basis of Jethro Tull's horse-hoeing husbandry and of the Lois-Weedon system of alternate husbandry. Anybody, again, who visits an experimental farm, where the plots are separated by paths, will recognise the "fallow effect" in the increased vigour of the outside rows bordering the bare soil. An explanation, however, was not possible until the discovery of nitrification some twenty years ago and the investigations which have been made into the conditions favouring the process.

All soils contain considerable residues of nitrogenous material which cannot reach the plant until they have been oxidized by various bacteria in the soil and so converted into nitrates. A summer's fallow provides just the conditions favourable to nitrification—warmth, aeration, the stirring of the soil, and the greater amount of moisture which results from the absence of a crop to dry the soil.

Gain of water by fallowing.—It is easy to ascertain that the fallowing results in a great gain of water to the soil; for example, at Rothamsted in 1904, halves of certain plots were fallowed while the other halves carried wheat. The soil was sampled in mid-September, after harvest, with the following results :—

	Percentage of water in fine soil.	
	Cropped.	Fallow.
1st depth of nine inches	17·4	17·2
2nd " "	18·8	20·0
3rd " "	20·1	22·3
4th " "	20·9	23·1

or down to the depth of 3 ft. an average gain of 1·35 per cent. of water, equivalent to 3·1 in. of rain. In a climate like that of Great Britain this extra water is a matter of little or no moment, since the land becomes saturated repeatedly by the winter rainfall, but in more arid countries it often makes all the difference to the crop. In parts of California, for example, it is only possible to take a crop like wheat every other year without irrigation, the bare fallow in the intermediate years being necessary to collect the rain for a full yield.

Accumulation of nitrates.—The chief gain, however, from a summer fallow lies in the way the nitrates are made and stored up in the soil for the benefit of the ensuing crop. The Rothamsted experiments illustrate the increase thus produced, for there one plot grows wheat every year without manure, and the second is divided into two portions, one of which is fallowed while the other is cropped every alternate year. The yield is as follows :—

	Wheat every year.		Wheat after fallow.	
	Grain.	Straw.	Grain.	Straw.
	Bushels.	Cwt.	Bushels.	Cwt.
Average crop per acre per annum, 1856–1902 ...	12·7	10·0	17·1	14·2

This shows a considerable gain for fallowing, but it must be remembered that the land in the second case is only cropped every other year, hence the production per acre under cultivation is only half as much, or $8\frac{1}{2}$ bushels per acre per annum.

The benefit of fallowing depends upon the formation of nitrates during the summer and their retention for the next crop, but heavy rain during the winter may wash them entirely away and leave the land no richer. This is plainly seen if the results given above are divided into two groups according as the autumnal rainfall, September to December inclusive, is above or below the average :—

——	16 Seasons of less than average rainfall.	16 Seasons of more than average rainfall.
Rainfall (Sept.—Dec.)	8·88 in.	13·66 in.
Percolation through 60 in. soil ...	4·03 in.	8·92 in.
Total produce (wheat after wheat) ...	1,810 lb.	1,627 lb.
Total produce (wheat after fallow)...	2,743 lb.	1,757 lb.
Percentage increase due to fallow ...	51·5	7·9

Thus when followed by a dry autumn, the fallowing produces an increase of more than 50 per cent. in the ensuing crop, whereas if the winter be wet the increase due to fallowing is little or nothing.

It therefore follows that summer fallowing is only likely to be of direct benefit to the next crop where the climate is dry and no great amount of percolation takes place through the soil in the winter. It is, on the whole, more likely to result in a permanent loss of fertility, and can only be justified on those heavy soils which need an occasional rest to maintain their condition and restore a good tilth.

Clover Crop v. *Bare Fallow*.—Another of the Rothamsted experiments illustrates how much may be gained by a clover crop in place of a bare fallow. One of the fields is farmed under a four-course rotation—swedes, barley, clover or fallow, wheat ; one half of the plots growing clover and the other fallowed before the wheat. The better the clover the better the ensuing wheat, and if we compare the succeeding crops after a good clover year its benefits are very marked :—

——	Clover Hay.	Wheat.	Swedes.	Barley.
	Cwt.	Bushels.	Tons.	Bushels.
Clover plot	76·7	39·5	19·4	36·3
Fallow plot	—	32·5	19·0	28·3

Although nearly four tons of clover hay were removed, the residues, roots and stubble, were sufficient to increase the wheat crop by 21 per cent.; the root crop which came next by 2 per cent., although the same manure was put on both crops; and finally the barley, three years after, by 28 per cent.

Conclusion.

From all these results it will be seen that a bare fallow can never be a directly profitable operation and has no justification on free-working land. But with strong clays in dry climates, as for example over much of the East and South-East of England, it may often be necessary to clean the land and restore its friable texture; on such soils also there is least likelihood of loss through the washing out of the reserves of nitrogen which have been rendered available by the process. Bare fallowing may in such a case be useful.

4, Whitehall Place, London, S.W.,
May, 1906.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 173.

BOARD OF AGRICULTURE AND FISHERIES.

Potato Growing.

Potatoes are grown successfully on many kinds of soil, but a sand of good "body" or a medium loam is best adapted for the crop. Fen lands and reclaimed bog are also admirably adapted for potatoes. An essential condition of a good potato soil is porosity, and the Old Red Sandstone soils of Dunbar are famous as potato soils. With regard to their place in the rotation there is no fixed rule, but in most cases potatoes follow corn. Occasionally they are grown after "seeds," which, as a preparatory crop, has many points in its favour. The decaying vegetable matter furnished by the sod is valuable not only as a source of food for the plant, but also on account of its beneficial influence on the physical condition of the soil.

The habits of the plant demand a good tilth. The land should therefore be ploughed deeply in autumn and cross-ploughed, if possible, in early spring.

Seed.

Small compared with Large Seed.—The success or failure of the crop largely depends on the character of the seed tubers. In many parts of the country it is the practice to plant small tubers, the bigger ones being sold for cooking purposes. There is considerable diversity of opinion as to the best size of seed to plant; a few growers prefer large tubers, but most believe that equally good results will be obtained from small ones. Four years' experiments at Cambridge show that tubers of $1\frac{1}{2}$ to $1\frac{3}{4}$ ins. in diameter are more profitable to use than others, as they yielded a larger proportion of ware and a lower percentage of diseased tubers.

In discussing their cropping capabilities, two kinds of small potatoes must be considered: (1) the late-formed tubers of strong, robust plants, and (2) the produce of plants of low vitality. If the bulk of the seed consists of the former, then quite satisfactory returns may be obtained, as the tubers are small simply on account of their having had insufficient time to reach full size; if the seed, however, be the small, stunted produce of weakling plants, only weakling tubers can be expected from them, practically all of which will fall into the seed class. Whilst it may be possible, therefore, to obtain a good crop the first year from small seed, owing to the likelihood of the seed consisting largely of tubers formed late in the season, the chances are

that if seed from the same stock be used for a number of years in succession, there will be an ever-increasing proportion of the produce of weakling tubers, with the result that the returns will become more and more unsatisfactory.

It is probable that when potatoes are being grown for seed purposes large tubers are more satisfactory as sets, more seed-size tubers being produced, but that for marketing cooking tubers the use of small sets is desirable.

Whole compared with Cut Seed.—Experiments have shown that whole tubers about $1\frac{1}{2}$ to $1\frac{3}{4}$ ins. in diameter generally prove the most profitable for planting purposes. Should the supply of whole seed run short it is unwise to make good the deficiency by cutting seed-size tubers. No serious reduction in yield, however, need in general be feared from the use of sets obtained by cutting large tubers of the round or pebble type. With this class of cut sets the weight planted per acre may be considerably greater than when seed-size potatoes are planted whole, but, on the other hand, the produce will sometimes contain a less proportion of "small" tubers than the produce of whole seed. In cutting tubers for seed one or more of the buds at the rose end should be included in each set. Planting should be done directly after cutting, and the sets covered in with as little delay as possible. Exposure even during the dinner hour may be sufficient materially to reduce the yield from cut sets.

Liming the Cut Surface.—When, however, it is necessary to prepare seed a day or two in advance of planting, the tubers as soon as cut, should be sprinkled with finely-powdered lime. The effect of the lime is to form a "scab" over the wet surface of the set, which prevents, or, at any rate, considerably retards, evaporation of moisture.

Change of Seed.—Vigour and disease-resistance are affected by the age of the variety. New varieties are generally more vigorous; the longer vegetative reproduction is carried on the weaker a plant becomes. Further, too much stress can hardly be laid on the importance of change of seed. New seed is unquestionably more disease-resisting than seed that has been grown on the same farm for a number of years, and to secure the biggest crops, apart altogether from the question of disease, it would seem to be necessary to introduce new seed every year, or at least every second year. At Garforth, in 1903, *new* seed of four well-known varieties, viz., British Queen, Challenge, Conquest, and Eightyfold, produced, on the average, better crops by 3 tons 9 cwt. per acre than seed from stock which had been grown *four* times without change. Moreover, the crops from the new seed were not diseased, whereas on the average 22 per cent. of the crops from the older seed were diseased. In both cases the seed was procured from Scotland.

The following results, also obtained at Garforth from Scotch seed, indicate that it may be profitable to change the seed after the *second* year in Yorkshire; further south it is always advisable to change after the second year :—

Name of variety.	Yield per acre.			Diseased tubers per acre.	
	Second year on farm.	Third year on farm.	Balance in favour of the newer seed.	Second year on farm.	Third year on farm.
	T. c. q.	T. c. q.	T. c. q.	lb.	lb.
British Queen ...	12 19 0	11 13 1	1 5 3	nil.	160
Conquest	12 7 1	9 10 3	2 16 2	120	1,200
Royal Kidney ...	12 2 2	11 11 2	0 11 0	nil.	40

In the season 1905 experiments on "change of seed" were made at Cambridge, and the following figures were obtained for four varieties :—

Variety.	History of Seed.	Total Crop.		Increase due to change.	
		Tons.	Cwt.	Tons.	Cwt.
Up-to-Date ...	Five years in Cambridge ...	4	17		
"	Fresh from Cromarty ...	14	13	9	16
British Queen	Three years in Cambridge ...	5	3		
" "	Fresh from the Lothians ...	15	13	10	10
Northern Star	Three years in East Anglia	4	15		
" "	Fresh from the Lothians ...	17	13	12	18
Factor ...	Three years in Cambridge ...	10	10		
" ...	Fresh from the Lothians ...	15	8	4	18
" ...	Grown in Cromarty, 1904, from Cambridge seed ...	11	12	2	6
" ...	Grown in Norfolk, 1904, from Cambridge seed ...	9	6		

Here the benefits of change of seed are shown in the clearest possible way.

Results obtained at various stations in England furnish additional evidence with regard to the benefits to be derived from frequent changes of seed.

It may be pointed out that new seed should be obtained as early in spring as possible, before sprouting has commenced, so that the damage which sprouted potatoes suffer in course of bagging and transit may be avoided.

Scotch and Irish Seed.—That Scotland and Ireland afford a good change of seed for England has long been known, but why this should be so is not quite clear. A number of influences are probably at work. It seems probable that the

increased vigour of potato sets from Scotland and the North of Ireland is due not only to a difference in soil and latitude, but to the extra moisture available during the period of growth and to reduced sunshine during the time of ripening. In spring such seed is slower in sprouting than the English, and therefore runs less risk of damage ; in the case of main crops, however, experiment points to damage from quick sprouting as being practically negligible.

During the past few years experiment has shown that seed tubers from Ireland are about equal in cropping power when grown in England to those sent south from Scotland. Two experiments at Cambridge, one in 1908 and the other in 1910, tend to prove that seed from the west, north-west, and south-west parts of Ireland is distinctly better and produces heavier crops than seed obtained from the east side of that country.

A potato grower in the east of England may reasonably expect an increased yield of potatoes of from 2–3 tons per acre if he changes his seed every two years, and he will be equally safe in purchasing his stocks either from Ireland or Scotland, provided he uses his judgment in making inquiries beforehand.

Immature Seed.—To ascertain the value of immature seed a test was made at Garforth in 1905, the seed of a number of varieties being lifted in 1904, (1) in *immature* and (2) in *mature* condition. To obtain seed in an *immature* state small quantities of a number of varieties were lifted whilst the tops were still green and the skins of the tubers tender. For the *mature* seed the same varieties were lifted at the usual time, when the tops were quite dead and the skins of the tubers tough. Two varieties, grown for the third time on the farm without change of seed, showed an average advantage of 24 cwt. per acre in favour of immature seed, while three others, grown for only the second time on the farm, gave practically no advantage with immature seed. The stock from which the varieties were grown was obtained from Scotland.

Immature seed, however, can be better obtained by planting a late patch of potatoes, say some time in June. The produce from such will be mostly composed of "seed" and "small" potatoes, and seed obtained in this way seems to be well adapted for storing even under the ordinary conditions of the pie or clamp. Immature seed, obtained by the first method described, is not well suited for storage in pies.

Storing of Seed.

During recent years different methods of storing seed have been tested, and the practicability of growing in the later districts considerably larger crops than formerly has been clearly demonstrated.

Boxing in Autumn.—According to this method, which has been largely adopted for some years by the growers of early potatoes, seed-size tubers are placed in the autumn in shallow boxes containing no soil or other material, and stored throughout the winter in tiers in a cool, well-ventilated and well-lighted shed. No artificial heat need be used. From time to time the order of the boxes in the tiers should be reversed so as to ensure an equal amount of light to all the potatoes. This treatment leads to the "greening" of the tubers and the development of short, sturdy green sprouts, which do not break off during planting, and the crop gets an "early start." Further, experiments conducted at Kew showed that "greened" tubers lose only about one-sixth as much in weight during the season as those not "greened," and are therefore firmer; while "greening" will to a great extent check the ravages of winter rot. The method, however, involves a good deal of labour at a time when work presses, and, further, accommodation for boxes is often lacking on farms at this season of the year. In the southern and eastern districts no advantage is usually to be gained by sprouting the seed of late varieties.

Boxing in Winter or Early Spring.—This method permits of tubers being "pied" straightway in autumn and transferred to boxes in winter or early spring, whenever weather conditions are suitable and men can be spared for the work. The question of accommodation and protection from frost is not so serious in spring.

In some cases quite as good crops have been grown from seed stored in this way as in the former, but in general it is less satisfactory to box in winter and early spring than in the autumn.

A very convenient box is that illustrated on p. 6. From 100 to 120 of these will be required per acre, and the cost may vary from 30*s.* to 40*s.* per acre, the boxes, however, lasting several years.

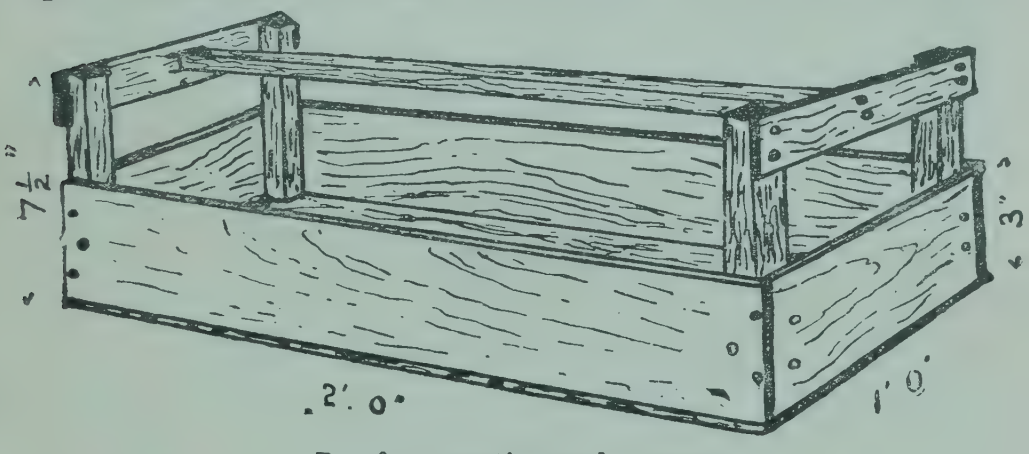
Pieing in Autumn and Planting direct from the Pie.—Both of the methods just described have proved superior to the ordinary one of planting direct from the pie. All three were first compared at Garforth in 1903. For the test in that year the variety planted was Up-to-Date, and an advantage of two tons per acre followed the use of boxed seed. In 1904, five varieties (second early and late) showed an advantage of 33 cwt. per acre in favour of boxed seed. In 1905, an average increase of one ton per acre was produced at Garforth by seven varieties when boxed seed was used.

In each year these results were obtained from Scotch seed, introduced into Yorkshire in the previous season, and, as

might have been expected, excellent crops were obtained without any special treatment. Even with such seed, however, boxing resulted in a profitable increase.

It must, however, be stated that in each of the trials the potatoes were planted in May. Further experiments appear to show that as great advantages are not obtainable in districts where planting is possible about the beginning of April.

Where large areas of potatoes are planted it is difficult to provide sufficient boxes for the seed, or accommodation for



Box for sprouting seed potatoes.

the boxes, but it should at least be possible to box the earlier varieties. If it be found impracticable or unnecessary to box the seed of late or maincrop varieties, which do not sprout in the pies to the same extent as the early varieties, it is perhaps better to spread the seed in a thin layer on the floor of a dry, well-lighted shed, than to leave it in the pie till planting time.

The free admission of light is important. It has the effect of producing a slow, sturdy growth of sprouts which are much less liable to be knocked off at planting time than the pale, elongated sprouts produced in the dark.

In addition to minimizing the damage to sprouts, early removal of the seed from pies is beneficial for another reason. Rotting frequently takes place in the pie, sometimes to a serious extent, and sprouts which have come into contact with rotten tubers are often considerably damaged, and not infrequently killed. Rotting may be checked by dusting the tubers freely with quicklime before pieing. Lime used in the "quick" form readily becomes detached from the tubers in spring, leaving them clean and dry. Slaked lime should not be used, as it adheres to the tubers in a pasty condition, and on drying becomes firmly attached to them. Sprinkling the tubers with powdered sulphur at the rate of 2 lb. per ton of tubers also holds winter rot in check.*

* See also Leaflet No. 193, *Winter Rot of Potatoes.*

Choice of Variety.

Success or failure in potato growing is determined largely by the choice of variety. The seed may be in first-class condition, the soil and manures may be the same for all, and yet one variety may yield tons per acre less than another. In testing varieties of potatoes it is especially important that the stock from which the seed for the test is drawn should have been grown under the same soil and climatic conditions.

The value of a variety should not be gauged solely by its cropping capacity. *Cooking quality* is a very important point, which is, however, largely dependent on soil and season. Good cooking tubers should not lose colour on boiling, but should remain creamy white; they should be mealy, with a glistening fracture; and they should remain white on cooling. *Disease-resisting power* is a most important consideration, and so also is the natural tendency of the variety to form tubers the bulk of which are big enough to be put upon the market as ware. Choice of variety, also, must be governed by the *demand of the market.* There are many good coloured varieties, but the demand for such in city markets is comparatively limited, and it certainly pays best to grow only those that will meet a ready sale. Out of a large number of varieties tested during the past few years, the following may be taken as best fulfilling general conditions:—

First Earlies.—Midlothian Early, Recorder, Ninetyfold, Conquest, Sharpe's Express, Dalmeny Early, Eclipse, Epicure, May Queen, and Sir John Llewellyn.

Second Earlies.—British Queen, British Queen II, Dalmeny Radium, Cottar, Royal Kidney and King Edward VII.

Late or Maincrop Varieties.—Up-to-date or varieties of a similar type, such as Duchess of Cornwall, Factor, Table Talk, Dalmeny Beauty, and Dalmeny Regent; Langworthy, What's Wanted, Golden Wonder, and Northern Star.

Where Wart Disease has occurred, the varieties mentioned in Leaflet No. 105 should be grown.

*Manuring of Potatoes.**

Probably no crop grown on the farm receives more manure than the potato crop. Though, in most cases, the plant responds readily to liberal manuring, it is doubtful if it is a greedier feeder than other "fallow" crops. It should be borne in mind that the largest possible crop is not always the most profitable, and that an excess of manurial ingredients over the requirements of the crop may lead to considerable

* Further information regarding the manuring of potatoes will be found in Leaflets No. 80 (*The Use of Artificial Manures*) and No. 106 (*Fertilisers for Market Garden Crops*).

waste. It may be argued that any such excess will benefit future crops, but the farmer wants the highest possible return on the first crop—"residual value" being frequently a more or less doubtful asset.

Dung alone.—In manuring potatoes a certain amount of dung is always beneficial. It may be applied at different periods of the year, but most experiments show that spring applications give the best results. A dressing of 20 tons of dung per acre is not uncommon, and with such treatment alone good crops may often be obtained. It frequently happens, however, that the foliage is encouraged at the expense of the tubers, especially when artificials are also applied, and actually heavier and more profitable crops can be grown by using half the above quantity of dung with artificials. If the land is in very poor condition, 20 tons of dung may prove more profitable than 10, but in many cases the former quantity is too large to be applied with profit.

Dung Supplemented with Artificials.—The most common system of manuring potatoes is to apply a moderate dressing of dung—say about 10 tons per acre—and supplement it with artificials. In the use of the latter along with dung caution is necessary; artificials are probably too frequently applied in excess of the requirements of the crop, smaller profits being consequently obtained than when more economical methods are followed.

When crops of from 9 to 10 tons per acre can be grown solely by the aid of moderate dressings of dung there is a risk that any increase in yield obtained by the additional use of artificials may be produced at too great a cost.

The following mixture of artificials per acre may be recommended as a safe and reliable one under most circumstances, and no farmer should use artificials in greater quantity along with 10 tons of dung until he has thoroughly satisfied himself by experiment that it can be done with profit:—

1 cwt. sulphate of ammonia.
2 to 3 cwt. superphosphate.
1 cwt. sulphate of potash.

In view of the valuable nature of the crop, especially in the case of early potatoes, farmers can not only afford to manure liberally, but it will also pay to compound more complex mixtures than in the case of less valuable crops. The following mixture (5 to 8 cwt. with dung) has given excellent results and will be found generally serviceable:—

½ cwt. nitrate of soda.
½ cwt. sulphate of ammonia.
2 cwt. dissolved bones.
2 cwt. superphosphate.
1 cwt. sulphate of potash (containing about 50 per cent. of potash).

The Effect of Artificials when no Dung is Applied.—Though dung is generally regarded as essential in the manuring of potatoes, very good and highly profitable crops can be grown without it.

The following mixture of artificials per acre may generally be depended upon to produce as big a crop of potatoes as 10 tons of dung :—

2 cwt. sulphate of ammonia.
4 cwt. superphosphate.
2 cwt. sulphate of potash.

Dung, when readily obtainable, will doubtless prove more economical than the above mixture of artificials, but there are times—*e.g.*, after "seeds"—when such a mixture alone will give quite as profitable returns as 10 tons of dung.

Sulphate of Ammonia v. *Nitrate of Soda.*—When used with dung there is generally little to choose between these two sources of nitrogen in regard to the yield of the crop, but when no dung is used the results are mostly in favour of sulphate of ammonia.

Calcium Cyanamide and Nitrate of Lime.—Experiment has shown that in some cases these fertilizers are about equal in value, nitrogen for nitrogen, to sulphate of ammonia.

Different Potash Manures.—Sulphate of potash will, in most cases, give the best results, but there is so little to choose between the sulphate and the muriate that a farmer should be guided by their respective unit prices at the time of purchasing.

Both these forms have proved superior to kainit. There is an idea prevalent amongst farmers that kainit, owing to its attractive power for moisture, is superior to the other forms on sandy or light soils, especially in a dry season. This, however, does not appear to have been borne out by experiment.

Rape meal.—As a manure for potatoes, rape meal is held in high favour in districts where the soils are light in character. It contains about 5 per cent. of nitrogen and 4 per cent. of phosphates, and, like most organic manures, decomposes slowly in the soil. A mixture consisting of 2 cwt. rape meal, ½ cwt. sulphate of ammonia, and 1 cwt. sulphate of potash, with 10 tons of dung per acre, has given very satisfactory results on light soils in Yorkshire.

The Effect of Manures upon Cooking Quality and Disease.

Cooking Quality.—The quality of the potato is dependent upon many factors, including soil, season, variety, the state of ripeness of the tuber, and the system of manuring. The application of a heavy dressing of dung appears to depreciate somewhat seriously the value of a potato for cooking purposes. A moderate dressing is considerably

less harmful, whilst the addition of a well-balanced mixture of artificials to a moderate dressing of dung will, other things being equal, produce potatoes of the first quality. Sulphate of ammonia is preferable to nitrate of soda when used in conjunction with dung, but when no dung is applied nitrate of soda, as an ingredient of a mixture of artificials, may be quite as satisfactory as sulphate of ammonia in regard to its effect on the quality of the produce. On soils requiring large quantities of potash, sulphate of potash should be employed in preference to either muriate of potash or kainit.

Disease.—Manures which tend unduly to stimulate the growth of the foliage, such as heavy applications of dung or mixtures of artificials containing a rather high percentage of nitrogen, render the plants more liable to disease.

Planting.

Time of Planting.—Potatoes should be planted in spring, as soon as a good tilth can be obtained. April is generally a suitable month, but planting is sometimes possible towards the end of March, while good returns are not infrequently obtained from seed planted in May. When, however, no special precautions—such as boxing—are taken to preserve the first sprouts, it is advisable to plant the potatoes so that they shall, as far as possible, make their first growth in the soil. A good covering of soil will protect the sets from frost, even when planted as early as the end of March, but as soon as the weather becomes fairly mild part of the covering should be removed by harrowing, as weak and spindling sprouts result if they have to push their way through a considerable thickness of soil before reaching the light.

Depth of Planting.—As to the proper depth to plant, a great deal depends upon the character of the soil. Where the soil is loose and friable it is possibly advantageous to plant fairly deeply. When dung is applied in the row the danger of the sets being covered too much is minimized, but when potatoes are planted without dung in the row there is considerable risk of their being covered too deeply, especially on the heavier class of soils.

Distance Apart.—The width between the rows, and the distance between the sets in the rows also depends upon the local conditions, but in general 26 inches between the rows and 15 inches between the sets will prove satisfactory. On the other hand, on some soils and in some localities 12 inches between the sets has yielded a better crop.

Time to Lift Potatoes.

It is highly important that potatoes should be lifted as soon as they are ripe. It has been demonstrated repeatedly

that comparatively healthy crops can be obtained even from those varieties which are generally regarded as being very liable to disease (*Phytophthora*) if attention is given to this point.

Formation of the Pie.

The general principles on which a pie or clamp is made are practically the same throughout the country. The method of covering the pie, however, varies considerably, but the following may be safely recommended. The usual roof-shaped pie is covered with a layer of straw about 6 in. thick. A plank about 1 ft. broad and from 8 to 10 ft. long is then placed along the top or ridge of the pie, and the sides to the edges of the plank are covered with an inch or two of soil. The plank is then moved along and another length is covered with soil. In this way the top of the pie is kept free from soil, thus providing for ventilation. It may be necessary to add more soil to the sides later in the year, but the top is left untouched except, perhaps, in a time of severe frost, when a covering of potato haulm is put over the straw. Potato haulm should not be used for this purpose, however, unless the crop from which it was derived was quite free from disease.

Diseases of the Potato.

The potato crop is subject to several fungus diseases which may cause serious loss both in yield and quality of the produce. A number of these diseases are dealt with in certain of the Board's Leaflets, as follows:—No. 23 (*Potato Disease*); No. 105 (*Wart Disease of Potatoes*); No. 117 (*Black Leg or Potato Stem Rot*); No. 137 (*Varieties of Scab in Potatoes*); No. 164 (*Potato Leaf Curl*); No. 193 (*Winter Rot of Potatoes*); No. 232 (*Corky Scab of Potatoes*).

4, Whitehall Place, London, S.W.,
October, 1906.
Revised, February, 1911.

Copies of this leaflet may be obtained, free of charge and post free, on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 23 leaflets dealing with the Cultivation of Fruit Trees and Farm and Garden Crops may be obtained from the same address, price 1d., post free.

BOARD OF AGRICULTURE AND FISHERIES.

Tree Root-rot (*Armillaria mellea*, Vahl.).

This destructive parasite, also known as Collar Rot and *Agaricus melleus*, is one of the most abundant and widely distributed of British "toadstools." In addition to attacking nearly all kinds of orchard and other broad-leaved trees, it is parasitic upon European and some introduced conifers.

Description.

The fungus, in common with many other kinds, grows in dense clusters round the roots of living trees, also round dead stumps. In some instances it appears to grow directly from the ground, but careful examination in such cases shows that the mycelium springs from buried wood, roots, &c. It is distinguished by the dingy honey-yellow coloured cap being covered, more especially towards the centre, with small, darker scales; the stem is coloured like the cap and has a frill or ring near the top; when young this frill extends from the stem to the edge of the cap and conceals the gills, which are whitish. Myriads of spores are produced, which form a snow-white powder on whatever they fall. These spores are distributed by wind, game, mice, &c., and aid greatly, but not solely, in spreading the disease.

Indications of Disease.

Usually the first indication of disease is the drooping and yellowing of the foliage. When this symptom manifests itself, the presence of a thin, firm, white sheet of mycelium, situated between the bark and the wood at the collar, or on the main root-branches, clearly indicates *A. mellea* as the cause of the mischief. This felted white mycelium often extends up the trunk between the bark and the wood for several feet, and changes gradually into blackish cord-like strands of mycelium, called rhizomorphs, which continue to grow upwards between the wood and the bark as the latter becomes dry and separates from the wood. These cord-like rhizomorphs become variously branched, and anastomose to form an irregular black network, so frequently met with on removing the bark from a dead trunk, indicating the cause of its death. Black rhizomorphs may also be found surrounding the root-branches. In fact, these first infect the tree by penetrating the bark of the root and giving origin to the white mycelium.

Prevention and Remedy.

1.—When the leaves of a tree droop and turn yellow owing to the presence of the fungus, curative measures are hopeless, as the mycelium has by this time completely girdled the trunk. Nevertheless, it is very important at

this period to adopt measures against an extension of the disease. When a tree has been killed the black rhizomorphs surrounding its root extend in all directions about three or

I.—Cluster of Armillaria mellea. II.—Rhizomorph on Root.

four inches below the surface of the ground in search of living roots of a fresh tree. When such are encountered, the tips of the rhizomorphs pierce the bark and give origin to

the white mycelium, which eventually kills the tree. These underground rhizomorphs travel for an unlimited distance in the ground, and, unless checked, constitute a continual source of danger to trees surrounding the one attacked.

When a tree is attacked a portion of the bark at the collar should be removed, and if the white mycelium is found to have passed up the trunk the case is hopeless, and the wisest course is to cut down the tree, and remove as much as possible of the root, which should be burned. The roots should not be used for ornamenting, as when this is done, dense masses of toadstools appear in due course, and the underground rhizomorphs spread on every side.

2.—If the mycelium has not entered the trunk, but is confined to certain branches of the root, these should be removed, and as much as possible of the root exposed, and covered with a mixture of equal quantities of quicklime and powdered sulphur. This mixture should also be placed round the base of the trunk before the soil is filled in.

3.—Whether a diseased tree has been removed, or treated in the hope of recovery, a trench about eight inches deep and six inches wide should be made all round the site of the tree, at a distance well outside the spread of the branches. The object of the trench is to intercept the spreading rhizomorphs. If in a situation where an open trench can be allowed to remain, this is all that is required to be done. If the position is such that an open trench would be objectionable, planks about six inches deep, well coated with gas-tar, may be let into the ground instead, and will answer the same purpose. In making the trench it is important that the soil removed be spread over the ground enclosed by the trench.

4.—When the toadstools appear at the base of a trunk, they should be collected and buried ; crushing them underfoot is worse than useless, as this only aids in the dispersal of the spores.

5.—Great care should be taken not to injure the base of the trunk or exposed roots, as the spores can only enter the tree through a wound. The grass-mower is responsible for many wounds, through which this and various other fungi parasitic on trees first gain an entrance.

4, Whitehall Place, London, S.W.,
July, 1906.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 12 leaflets dealing with Fungi injurious to Fruit and Fruit Trees, and another containing 20 leaflets, dealing with Forest Trees and their Diseases, may be obtained from the same address, price 1d. each, post free.

Leaflet No. 175.

BOARD OF AGRICULTURE AND FISHERIES.

The Use of Waste Organic Substances as Manures.*

There are several ways in which a manure may be beneficial, but in general most manures serve one or more of four purposes, which are :—

1.—*To increase the supply of available plant food, either directly or indirectly, through its solvent action on the soil.*

2.—*To improve the mechanical condition of the soil.*

3.—*To hold up water in the soil and so ensure a constant supply to the plant.*

4.—*To favour the growth and work of micro-organisms on whose activity the productiveness of the soil to a certain extent depends.*

Value of Organic Manures.

Mineral substances, with the exception of lime and basic slag, chiefly serve one function only,—they supply plant food; but organic substances, like dung and the products described below, act beneficially in all the directions already enumerated. They furnish plant food, although the proportions are not well balanced, and somewhere in the rotation the proper mineral substances must be added if the best results are to be obtained. They have a marked effect on the mechanical condition of the soil : a heavy soil is lightened by their mere presence and also as a result of their decay ; and a light soil is improved by the cementing action of the glue-like colloidal humus to which they give rise. Without organic matter it is difficult to secure a good tilth.

One of the most valuable properties of organic manures, and one in which they far surpass artificials, is their remarkable power of holding water. The water supply in many soils is insufficient for securing maximum crops ; the manuring and cultivation adopted would give much better results if more water were present, provided, of course, it had no depressing effect on the soil temperature and air supply. This question will probably assume even greater importance as the necessities of the towns compel them to sink more and deeper wells in the country. Already in many districts the water level appears to be lower than it was ; shallow wells are in consequence left dry and have to

* Other Leaflets dealing with Manuring of Farm and Garden Crops are No. 72 (*Purchase of Artificial Manures*); No. 80 (*Use of Artificial Manures*); No. 93 (*Farmyard Manure*); No. 106 (*Fertilizers for Market Garden Crops*); and No. 170 (*The Uses of Lime*).

be deepened, and the supply available for the fields promises to be still further curtailed. Proper cultivation and the application of organic manures are two good ways of conserving the water supply.

Organic matter is not indispensable; crops can be grown on an experimental scale without it. But the advantages due to its presence are well recognised, and it should be replaced as it disappears from the soil in consequence of bacterial and other actions. The farmer uses dung, and the manure manufacturer frequently puts organic matter into his compound fertilizers.

There are a number of waste products, used at present only in special branches of farming, some of which deserve a more extensive trial. This leaflet deals with certain substances used in the hop gardens of Kent and Surrey, but there is no fundamental reason why their use should be restricted solely to hops, and some of them have been applied with great advantage to other crops. Nor is their use confined to a particular type of soil; they are generally applied to light chalky or sandy land, but this is by no means essential.

There are, however, certain drawbacks with regard to purchasing. The supply is somewhat irregular, and bulks are often not uniform; it is difficult to draw a representative sample for analysis, and dealers often decline to give any guarantee as to composition. Competition from other quarters may force prices up too high, while difficulties attendant on sanitary regulations may have a similar effect, or they may act in precisely the opposite direction. There is no uniformity of price; indeed, prices vary in neighbouring districts in an apparently haphazard way, and the personality of the buyer is too important a factor. Little information is obtainable as to the relative manurial value of the various substances; the usual pot experiments are not quite satisfactory, because sufficient account can hardly be taken of the power to hold up water. It seems certain, however, that, provided the mechanical condition is satisfactory, these substances have more value than is commonly believed.

The prices quoted in this leaflet are those which the practical hop grower who is in a position to make favourable purchases finds it worth his while to pay.

The substances dealt with fall into three groups:—

1.—*Residues from animal carcases*: Dried blood, feathers, greaves, hair waste, hoofs and horns, rabbit waste, slaughter-house refuse.

2.—*Residues from manufactures*: Damaged cakes, shoddies, tannery waste.

3.—*Residues from towns*: Destructor refuse, night-soil, poudrette, sewage sludge.

1.—*Residues from Animal Carcases.*

Dried Blood.—This is an excellent fertilizer, and it is used by some manufacturers for their mixed manures. The price at which it is offered to farmers appears usually to be too high, in consequence, it is understood, of competition from America and the Continent. Usually about 12·3 per cent. of nitrogen is guaranteed, and prices in February, 1908, varied from £8 5*s.* to £10 per ton, or 13*s.* 4*d.* to 16*s* 3*d.* per unit.

Feathers and Feather Waste.—Excellent results are obtained in some hop gardens by using about 20 to 25 cwt. of feathers, and the limited supply (amounting probably to only a few hundred tons a year) is rather keenly sought after. Large feathers are slow in action, the shafts especially taking a long time to decay; a sample containing many of them is not as valuable as one composed mainly of small, more easily decomposable feathers. The nitrogen obtained is usually a little over 8·24 per cent., and a not uncommon price is £5 per ton delivered, giving a unit price of about 12*s.* In spite of the generally good mechanical condition, this price is, perhaps, too high. The price naturally fluctuates; farmers have been known to pay £5 15*s.*, while samples guaranteed to yield 9·9 to 11·5 per cent. of nitrogen have recently been offered at £5 12*s.* 6*d.* In the latter case, where the unit value averages 10*s.* 6*d.*, feathers cannot be considered dear.

Greaves.—Etymologically this word is the same as "gravy"; it denotes the refuse or sediment left in making tallow or soap grease. Clean samples, derived from butchers' fat and the trimmings of joints, are used as food for dogs, pheasants, and poultry; lower grades, obtained in melting down grease from other sources, are available as manure, and have been effectively used on hops, fruit, wheat and other crops. The composition varies, and the fluctuation in price is considerable, 50*s.* to £8 being perhaps the outside figures, but it is not difficult to fix a maximum value for a particular sample, because of the close relationship between greaves and meat guano. The latter article consists of well-dried and finely-ground greaves mixed with bone meal; as a manure it is superior to ordinary roughly-ground greaves, and a higher price may reasonably be paid for the nitrogen it yields. At present meat guano is being offered in Kent and Surrey at 14*s.* 6*d.* to 17*s.* per unit for nitrogen and 1*s.* per unit for phosphate; it should be used in preference to greaves unless there is a distinct difference in price. The prices asked for greaves are sometimes excessive: a sample yielding 4·12 per cent. of nitrogen and 5 per cent. of phosphate, and worth at the time from 50*s.* to 55*s.*, was offered to the Wye

College at £5. No doubt the varied uses of greaves as food, for meat guano, and as an ingredient of certain mixed manures had to do with the high price asked.

Hair (*Calf Hair*, *Hair Waste*).—This yields about 9·9 per cent. of nitrogen, but it does not easily decompose in the soil. As a rule the mechanical condition is very bad ; the hair is matted in lumps which resist all ordinary farm appliances and absolutely refuse to break down. They may be in the soil for an indefinite time without perceptibly diminishing. Calf hair has been known to remain for two years in a hop garden and at the end of that time still yield 9·9 per cent. of nitrogen when brought to the laboratory.

Having regard to its unsatisfactory mechanical condition, hair must be valued at less than feathers and much less than meat guano. Perhaps 4*s.* 10*d.* to 6*s.* per unit of nitrogen is fully as much as it is worth ; this would make its value about 50*s.* to 60*s.* per ton. At the same time, if it could be supplied in a finely divided state it would be more valuable ; even as at present supplied a higher price is often paid for it.

Hoofs and Horns.—The value of these is regulated mainly by their fineness ; high grade samples of horn shavings and finely-ground horns yielding 12·3 to 14 per cent. of nitrogen are largely used by market gardeners. Other grades yield about 9·9 per cent. of nitrogen, and 20 to 25 per cent. of phosphate. They contain some bone. The unit price of the nitrogen is about 12*s.* On the other hand, *whole* hoofs and horns and materials like trotter scutch (consisting of hair, hoof, and bone), sometimes bought by farmers, are of little value until they have been finely ground.

Rabbit Flick (*Rabbit Waste*).—This consists of the ears, feet, tail, and various other external portions of rabbits. The mechanical condition is usually very fair, but if the substance could be broken up a little more its value would be increased. It yields from 9·9 to 12·3 per cent. of nitrogen, and sells at about £6 per ton ; the unit value of the nitrogen therefore averages 10*s.* 9*d.* A certain amount of phosphate is invariably present. Rabbit waste is regarded by many practical men as quite a useful fertilizer, the only drawback being that the supply is rather restricted.

Slaughter-House Refuse, *Viscera*, *&c.*—The proper way to utilize slaughter-house refuse is to convert it into meat meal or guano, in which form it can easily be carried about without interference from sanitary authorities. Where those who contract to clean out cattle markets have the refuse removed in barges it finds its way to waterside farms. It is worth about the same price as town stable manure.

Waste Fish.—East Kent farmers are very fond of waste fish as a manure, and the loads of sprats and of "five fingers" occasionally obtainable are disposed of without

difficulty. Its use is not confined to hops; it has been applied with great advantage to mangolds. Owing to its particularly penetrating and unpleasant odour it is, as a rule, only available in districts directly connected with the sea.

Fish guano and meat guano, although obtained from animal carcases, have not been specifically dealt with in the preceding pages, because they are now no longer waste substances, but definite manufactured manures.

2.—*Residues from Manufactures.*

Damaged Cakes.—Damaged cakes, or meals or cakes unsuitable for feeding purposes, are occasionally offered to farmers as manure, and where it is possible to have them finely ground they are very useful substances. Rape meal really belongs to this category, and in view of its uniformity may be taken as the standard in fixing a maximum price.

In Kent and Surrey (and no doubt elsewhere also) the price of a unit of nitrogen derived from rape dust is about 20 per cent. higher than that of nitrogen from fish guano, which in turn is somewhat higher than that from meat guano. There is no obvious reason for supposing that the actual value as manure differs to this extent, and it is desirable that the matter should be settled by properly conducted trials.

Among the samples known to have been used as manure are several Bombay cotton cakes yielding 3 to 4·5 per cent. of nitrogen, and 0·2 to 4 per cent. of phosphate; also certain compound cakes, falling within the same limits of composition, which had in some way got mixed with excessive quantities of sand. The precise value of these cakes cannot be fixed; 9*s.* 8*d.* per unit might be offered in the first place for the nitrogen and 1*s.* for the phosphate, and the price finally agreed on should be well below that of rape meal.

Shoddy.—Writing a century ago about woollen rags, Young says in his "Farmers' Calendar" article (March): "They hold moisture, and are adapted for dry, gravelly, and "chalky soils, and succeed in dry seasons better than most "manures, but they do little good on wet soils. London "rags are found much better than those collected in the "country; but the danger of catching the small-pox in "chopping and sowing them deters many farmers from "their use." Six to ten cwt. per acre were ploughed in three months before sowing wheat and barley; one ton per acre was dug into hop gardens. The rags cost about £4 to £6 per ton on the farm.

To-day woollen rags usually go first to the manufacturer to be torn up, shredded, and again made into cloth, only the portions which cannot be utilized in this process being available as manure. Considerable admixtures of dirt, cotton, and occasionally oil, may be present, but the mechanical condition is, as a result of the shredding, excellent.

Shoddies may conveniently be divided into three classes:—

(1.) *High grade*, yielding 12·3 to 13·2 per cent. of nitrogen, or, in the case of silk waste, 14 per cent.; the samples are clean and pure, and often highly coloured. This class includes carpet waste, and high quality cloth clippings. The supply is somewhat limited, manure manufacturers taking a considerable quantity; the price is therefore high, and varies between 9*s.* and 10*s.* 3*d.* per unit of nitrogen.

(2.) *Medium grade*, yielding 4·9 to 7·4 per cent. of nitrogen. The samples show considerable variation, and it is often difficult to obtain any guarantee as to their quality. This class includes wool combings, wool waste, flock dust, and the poorer qualities of cloth clippings. The supply is larger and prices are lower than for the higher grade, but samples are not always sold on the basis of their composition, and during last year (1907) variations of from 7*s.* 3*d.* to 9*s.* 8*d.* per unit of nitrogen have occurred. Probably 8*s.* 6*d.* might be taken as an average quotation.

These shoddies are widely used in hop gardens, and with such good results that they deserve a wider trial. They have been occasionally used with good effect on other crops, and are not so slow acting as has sometimes been stated.

(3.) *Low grade*, yielding about 2·5 per cent. of nitrogen. These are usually offered at from 4*s.* 10*d.* to 6*s.* per unit, and when this price includes delivery it cannot be considered high. Near the place of origin (Yorkshire) the prices are considerably less.

Refuse from Tanneries.—Leather dust, yielding about 3·5 per cent. of nitrogen, is occasionally offered to farmers, but the recorded experiments show that it has little or no manurial value. The use of leather scraps in horticulture is occasionally stated to be beneficial, but the results may quite possibly be due to other causes.

Other tannery wastes do not appear to be much used by farmers, although some of them doubtless have distinct manurial value.

3.—*Residues from Towns.*

Destructor Refuse.—From the samples of this substance sent to the Wye College it cannot be supposed to have any greater value on the land than coal ashes of equal fineness.

Night-soil, Poudrette.—For many years the enormous quantities of night-soil obtainable in England have been almost entirely wasted. On the Continent efforts have been made to convert it into merchantable manures, either by desiccation or by mixing with various substances, such as

peat, ashes, slaughter-house residues, blood, or phosphates, the mixture being known as *poudrette*. In order to prepare this substance it is obviously necessary to employ the pan system, and as this is not in general favour in England the application of the method here is limited. The pan system is still in vogue in many town districts, and in some places poudrette is manufactured. It is in very good mechanical condition, and yields about 6·6 to 9·9 per cent. of nitrogen, 8 per cent. of phosphates, and up to 3 per cent. of potash. Excellent results have followed the use of 3 to 6 cwt. per acre.

In the absence of definite experiments on the subject it is difficult to fix a fair value for poudrette. It is commonly supposed that anything which has passed through the human or animal body must have a higher manurial value than before, but even if this be true for the whole of the excreta it is certainly not the case as regards the solid portion. The easily attackable parts of the food are taken up by the body and reappear to a great extent in the urine ; the more resistant portions appear in the solid excreta. Any method for the agricultural utilization of the fæces is defective if it fails to collect the urine, and the practical difficulties of doing this are very great.

If the quantities of poudrette available ever became considerable it would become a matter of great interest to compare it as a fertilizer with meat guano and fish guano.

Similar fertilizers of much lower grade, yielding 2 per cent. of nitrogen and 8 per cent. of phosphate, are occasionally offered in Kent, but their value being low the cost of handling becomes proportionately higher.

Sewage Sludges.—In most towns there is a sewage system, and the production of poudrette is impossible. Attempts have been made to utilize the sludge deposited from the sewage, and it has been found, especially with those containing lime, that they have some manurial value. Their action, however, is very slow, and they appear to be best adapted for slow-growing crops and moist climates. Sludges and sludge products should only be purchased and utilized under expert guidance.

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July, 1906.

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Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 10 leaflets dealing with Manures and Feeding Stuffs may be obtained from the same address, price 1d. post free.

BOARD OF AGRICULTURE AND FISHERIES.

Poultry Fattening.

Fattening is an unnatural and artificial process, which cannot be carried on for an unlimited period. A limit is fixed by the health of the bird, for no bird will bear more than a certain amount of close confinement combined with heavy feeding. About three weeks has been found to be the most suitable period, but some birds are not able to bear the treatment as long as this.

Selection of Birds.

Class of Bird Suitable for Fattening.—All birds are not ready for the fattening pens at a given age. This is largely on account of size, which is dependent upon such circumstances as the breed, date of hatching, previous feeding, weather, &c.

If the bird has been well fed from the start, far less fattening is required, and the bird is usually large enough to go into the fattening pens earlier than is the case with a sparsely-fed bird, which has only had sufficient food to develop a good frame without much covering. In this connection it is well to note that a bird fed entirely on grain is unlikely to be as forward as a bird fed on grain combined with soft food. Experiment has proved that ground grain is not only more freely eaten, but makes birds more fleshy than does whole grain, while it tends to more rapid growth.

All breeds of birds can be fattened, but some breeds lay on flesh far more rapidly and to a greater extent than others. The non-sitting breeds, in other words the layers, generally make the poorest table birds. Their surplus food and energy are utilized in egg production, and they do not put on much flesh. Good layers are very active birds, and their activity keeps them lean. They are usually more developed behind than in the breast parts, whereas the good table bird is generally more ample in front. The breast of the ideal table bird judged from the side should be somewhat of the shape of a parallelogram with rounded corners. It should have a long, deep, broad, nicely-rounded breast, the bone of which is long and straight. It should be small or soft boned, with white skin and legs.

Unsuitable Birds.—Certain birds are unsuitable for fattening purposes. All those intended for the fattening pens must be in a fair state of health, or they will not stand the strain. Very wild birds will not fatten well. Feather-eaters must on no account be placed in the pens with other birds, as they would worry them by continually picking at their feathers, and thus retard the growth of the whole pen of birds. Fighters must also be excluded.

Suitable Breeds.—Superlative excellence both for laying and for table use cannot be expected in one and the same bird, and hence it is best to employ special breeds for table purposes if they are intended to be sent to market.

Amongst pure breeds Dorkings, Sussex, Old English Game, Faverolles, Malines, Orpingtons, Langshans, Plymouth Rocks, and Wyandottes may all be used as table birds. Of these, the first seven named have white flesh.

The best cross-breeds are Old English Game—Dorking; Indian Game—Dorking; Faverolles—Buff Orpington; and Indian Game—Buff Orpington, and it is to this class of birds that attention is particularly directed. Sussex, Faverolles, Buff and White Orpingtons, and Malines, among pure breeds, and Old English Game—Dorking and Faverolles—Buff Orpington among crosses, are quick in growth and suitable for spring and summer chickens. The others are best adapted for winter fowls.

As a pure breed the old Sussex is difficult to beat. Old English Game are best crossed with another breed, such as the Dorking. The Heathfield fatteners prefer the old Sussex breed, and next to that Brahma or Plymouth Rock crosses. Indian Game—Dorking crosses should be more popular, for they often scale up to 10 lb. and more. Old English Game—Dorkings reach 7 to 8 lb.; Langshans, 10 lb.; Orpingtons, 7 lb. and over; Plymouth Rocks and Wyandottes, 7 to 8 lb. These weights, however, apply to special birds that have been well crammed. Faverolles are greatly favoured by the French, and they make capital table birds either pure or crossed with the Buff or White Orpington. The chickens come early to maturity.

It has been said that the non-sitters, such as the Leghorns, make the poorest birds for meat; but if they are crossed, say with a Houdan, a fair bird for the home table can be produced.

Best Age for Fattening.—Birds on a free range are usually more forward for their age than birds hatched and reared in confined runs, so that while from three to four months is the usual age at which a bird is ready to be fattened, size is the best guide.

An important point to remember is that at a certain age, varying with each case, a bird is in a condition to return a maximum amount of profit. It is important to know, not only just when a bird is ready to be placed in the fattening pens, but when in the fattening pens to be able to determine exactly when each bird, in turn, reaches its highest state of perfection, after which no more food should be given it. It should be fasted for 24 to 36 hours, and then killed at once. Experience alone can enable one to decide the proper time at which to cease fattening. The loss to a fattener on hundreds of birds kept a few days beyond their time would be very great. There is, moreover, a double loss, for if kept beyond a certain time, not only is a bird consuming unnecessary food, which costs money, but in addition it actually loses weight. The cost of labour and the space it is occupying have also to be considered.

Buildings and Pens.

Where sheds are specially built it is better to erect rather low sheds on the span-roof principle, allowing for only one tier of pens. This ensures more perfect ventilation.

Where barns or sheds are utilized for fattening purposes, the pens are sometimes placed in tiers one above the other, allowing room in front of each row for the food trough, so that starting about 3 feet from the ground, each row of pens comes nearer to the wall than that immediately below it. The fewer the number of tiers the better the ventilation, and where space permits one row only is much preferable.

The pens should be 20 inches high, 20 inches wide, and 7 feet 6 inches long. These are divided into three cages, each of which is then capable of holding five or six birds. They are usually made of a framework composed of any sort of stout wood—1-inch batten does well—the whole of the rest of the structure being composed of wooden rods. The rods are placed $1\frac{1}{2}$ inches apart all over, except in the front, where they are about 2 inches. Batten used throughout has been found very serviceable.

The floors in the Heathfield district are made of wood about 1 inch wide on the top and 1 inch in depth, narrowing to $\frac{1}{2}$ inch at the bottom to enable the manure to drop through more easily. Battens with the lower edges planed away do very well, whereas the material mentioned above has to be specially procured.

The rooms or sheds in which the birds are penned must be kept scrupulously clean by frequent lime-washing and the daily removal of all manure and stale food. The ventilation must be very free, but draughts should be avoided.

Troughs.—Troughs in the Heathfield district are very often cut out of a solid piece of wood ; but two pieces of board placed at right angles so as to form a broad V, and then closed at each end, answer the purpose. Troughs may be held in position by hooks and eyes where there are several tiers, as each trough, except that in the lowest tier, rests on the roof of the pen beneath. In the case of the lowest tier, two projecting pieces of wood will answer the latter purpose, hooks and eyes being again used to hold the troughs upright. At Heathfield they often hang by cords. The troughs should be kept scrupulously clean, being scalded and scrubbed twice a week, while no stale food should be allowed to remain in them.

Temperature.—Experiment has proved that the best temperature at which to keep birds, so as to secure the greatest possible increase of flesh, is 60° Fahr.; but temperature will vary according to the season, and should be regulated by ventilation, no artificial heat being employed. If the birds are kept in an overheated, overcrowded, stuffy shed, they will not fatten at all easily or well. On the other hand, if the sheds are draughty and cold in winter time, a good deal of the food is employed in replacing heat unnecessarily wasted. This would not be the case if a proper system of ventilation and adequate protection from cold were provided.

Single Pens Undesirable.—Birds do not fatten well if confined singly, as they are apt to pine. When several are penned together they thrive much better, for, being greedy, the sight of other birds eating causes each bird to strive to obtain its share. This proves a healthy stimulus to the appetite, and far more is eaten than would be the case were the birds penned singly.

Gain in Weight.

Experiments have been undertaken from time to time to determine the weight gained during the fattening period. There may sometimes be a loss during the first few days, as birds do not always take to the new state of things. If, however, weight is lost during the first week, it is usually more than compensated by the gain made in the second week.

During the first week there may be a slight loss in weight, or a gain varying up to, say, 10 oz. The greatest gain is nearly always made in the second week, and may be anything up to 1½ lb. During the third week the gain is not nearly so great, but may be as much as ½ lb. Very few birds can stand more than three weeks' fattening, and if kept for four weeks they will probably lose weight, or gain very little, possibly only 1½ to 2 oz. It is therefore inadvisable

to prolong the process beyond a period of three weeks. The gain in weight over the whole period varies from about $1\frac{1}{2}$ lb. to $2\frac{3}{4}$ lb.

Feeding.

The best plan, and the one most frequently adopted, is to feed the birds from the troughs for about ten days, after which they should be crammed by machine for the remainder of the three weeks. Some fatteners cram the birds for a week only, but a good deal depends on the birds. When sold after the trough feeding period without being crammed, they are usually known as half-fattened birds.

Number of Meals.—When being fed from the troughs the birds should have two meals a day, the food being left until they are thoroughly satisfied, after which it should be cleared away and the fowls left to digest their meal and drowse until the next.

Consistency of Food.—The consistency of the food during the trough-feeding period should be that of stiffish paste or porridge. A test of correct consistency is to take a handful and squeeze it. It should then pass through the fist in a thick stream that will support its own weight to the height of about an inch or so before falling over. A further guide is that the bird when eating it should be unable to drag lumps into the cage. If this is possible, it is a sign that the food is made too thick. If the food is too thin the bird will be unable to lift and swallow it properly.

Cramming.

There are three methods of cramming—by machine, by funnel, and by hand.

The Cramming Machine.—The method of cramming by machine is almost invariably adopted by English fatteners.

The cramming machines in general use have a round reservoir at the top which contains enough food for 100 to 150 birds. This is connected with a pump cylinder, the piston-rod of which is operated by a lever worked by the foot of the person using the machine. There is a nozzle, to which is attached a piece of rubber tubing, and through this the food passes into the bird's crop when the lever is pressed down by the foot. Immediately the lever is released, the piston is forced by a spring to return to its original position, during which operation sufficient food passes down from the food reservoir into the cylinder, in readiness for the next feed.

The mode of operation should be as follows :—The bird should be lifted carefully from the cage and placed under one arm, being held firmly but gently against the body of the operator. This obviates all struggling on the part of the

bird. The head of the bird is now taken in the hand of the same arm, so that the comb lies in the palm, and the mouth is opened with one finger, which holds down the tongue. The tube is then inserted. Immediately that is done, the head is passed over to the other hand and, the neck being stretched out, it is drawn by the head *towards the machine*, until the tube has passed down into the crop. On depressing the lever, the food passes into the bird's crop. One hand, during this operation, should hold the crop, where the end of the tube can be felt, and gauge carefully the amount of food received and required, this varying according to the size of the crop. When sufficient food has been forced in, the foot is removed from the lever, and the bird released. Care should be taken to remove the foot *before* releasing the bird.

The consistency of the food should be that of thick cream. Care should be taken to hold the tongue well down when passing the tube into the bird's throat, and to straighten the neck well, or accidents may occur.

The Funnel Method of Cramming.—The next method is by means of a funnel. The spout of this funnel is usually about 6 inches long, $\frac{1}{2}$ inch in diameter, and made very smooth to avoid injury to the bird's gullet, whilst the outlet should be on the slant. The operation is as follows :—The funnel is inserted so that it passes down into the bird's crop, and then with a ladle the food is poured into the mouth of the funnel until the crop is felt to be full.

The consistency of food for funnel-feeding should be about that of thin cream. This is a much quicker system than that of hand-cramming.

Cramming by Hand.—The hand method consists in making boluses of food and forcing them down the bird's throat. In this operation the bird is gripped between the knees. The head is held in the left hand, while the mouth of the bird is opened by the forefinger, which holds down the tongue. The bolus, which should be about $\frac{3}{8}$ in. thick, and about 1 in. long, is then dipped into a bowl of milk, and pressed by the forefinger down the throat. The bird's neck should then be drawn well up, so as to make an easy passage for the bolus, which is pressed gently down into the crop by running the forefinger and thumb of the right hand behind the bolus outside the gullet. The full meal usually consists of about twelve boluses, but judgment is of course required here. The hand process is said to produce absolutely the finest results, owing no doubt to the fact that a more concentrated meal can be given than by the machine or the funnel methods, but although practised on some farms, the process is too tedious to recommend itself to the large majority of fatteners.

Food to be Used.

The best results in this country appear to have been produced with Sussex ground oats, or pure ground oats, mutton fat, and milk, usually skim milk or butter-milk. Barley meal, buckwheat meal, fine wheat meal, and boiled and mashed potatoes, may also usefully be employed for fattening purposes.

One of the best foods is ground oats; with the addition of mutton fat and milk this makes a perfect fattening mixture. The combination of fat and milk is found greatly to improve the quality of the meat produced.

The poultry food known as Sussex ground oats is not pure, but contains a certain admixture of barley, which enables the grinding process to be carried out more thoroughly owing to the dryness of the barley. The Russian oat is generally used, as it contains less moisture than the English. It is the fineness of the meal that is supposed to produce such excellent results, owing to the ease with which it can be digested.

The mutton fat used is clarified and then stored away in barrels. If small quantities only are being dealt with, it can be placed to cool in pails. Mutton trimmings, which can be obtained from butchers at about 2*d.* a pound, are suitable for this purpose; and where large quantities are used they may be bought still cheaper. The birds are usually given the fat when the actual cramming commences, and, beginning with a small amount, are worked up to about $\frac{1}{2}$ oz. per diem. The fat should be melted down and then mixed in with the meal.

The milk is allowed to become sour before being used, and in this state it is believed to prevent sickness and to take the place of green food. Butter-milk is also very valuable.

If whole milk is used, less fat is required, but whole milk is too costly where fattening is being carried out for trade purposes. Where milk is unobtainable, molasses has also been tried, whilst sugar has been used by some. It is believed, however, that no other food is equal to the combination of ground oats, milk, and mutton fat.

The following mixtures are sometimes used in place of ground oats :—

1. Two parts of buckwheat meal, one part of maize meal, two parts of ground oats, mixed with soured skim milk or butter-milk.

2. A mixture of toppings, barley meal, and ground oats in equal parts, with milk as in 1.

3. Buckwheat meal, middlings, and ground oats in equal parts, with milk as in 1.

Maize meal is useful if mixed with other meals, but, unfortunately, it creates a yellow greasy fat. Potatoes are useful for trough-feeding also, but fat must be added, as they have practically none in their composition.

Fasting.—A most important point to remember is that on being first placed in the fattening pens all birds must be fasted for at least 24 hours. If this is not done some birds may refuse to eat. Fasting stimulates the appetite and induces the birds to commence feeding, after which little difficulty will arise.

Cost of Fattening.—The cost of fattening will naturally vary. A farmer who has his own milk, &c., will fatten chickens more cheaply than the man who has to buy everything. It is estimated, however, that the cost of fattening a bird for three weeks is about 5*d.* for food alone. Where outside labour is employed the total cost will probably be about 8*d.* per bird.

4, Whitehall Place, London, S.W.,
December, 1906
Revised, June, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W.

A pamphlet containing 16 leaflets dealing with Poultry and Bees can be obtained from the same address, price 1d., post free.

BOARD OF AGRICULTURE AND FISHERIES.

Precautions against Accidents caused by Farm Machinery.

Several cases in which serious accidents have occurred owing to the insufficient fencing of farm machinery have been brought to the notice of the Board, and they think it therefore advisable to draw the attention of farmers and others to the necessity for taking precautions against such accidents. In the case of certain classes of farm machinery, namely, threshing and chaff-cutting machines worked by any motive power other than manual labour, Parliament has enacted special provisions, and the Acts referred to later in this leaflet require the machines to be so constructed as to secure the safety of the person feeding the machine, and it is the duty of farmers to see that these requirements are strictly complied with.

The main provisions of the Threshing Machines Act, 1878, and the Chaff-Cutting Machines (Accidents) Act, 1897, are given below.

Threshing Machines Act, 1878.—This Act, which does not apply to Scotland or Ireland, provides that the drum and feeding mouth of every threshing machine, worked by steam or by any motive power other than manual labour, shall at all times when working be kept sufficiently and securely fenced, so far as is reasonably practicable and consistent with the due and efficient working of the machine.

Chaff-Cutting Machines (Accidents) Act, 1897.—This Act requires that so far as is reasonably practicable and consistent with the due and efficient working of the machine, the feeding mouth or box of every chaff-cutting machine worked by motive power other than manual labour shall be so constructed, or fitted with such apparatus or contrivance, as to prevent the hand or arm of the person feeding the machine from being drawn between the rollers to the knives, and that the fly-wheel and knives shall be kept sufficiently and securely fenced at all times during working.

A penalty of £5 may be imposed for non-compliance with these Acts, and provision is made for enabling constables to enter premises for the purpose of seeing whether the Acts are complied with.

With regard to other machinery used in farming, there are no statutory provisions of general application. In some cases, *i.e.*, where the premises on which the machinery is used constitute a factory within the meaning of the Factory Act by reason of articles being manufactured there by way of trade, &c., the provisions of that Act as to the fencing of

machinery, &c., will apply; ordinarily, however, farm machinery, being used solely for estate purposes, or ordinary farming, and not in the manufacture or adaptation of any article for sale, does not come under the provisions of the Factory Act. The importance, however, of securing the safety of the men working the machines, and also of safeguarding other persons against the risk of accident, ought not to be overlooked, and the Board would urge all farmers to take special precautions in this direction. All shafting, whether vertical, horizontal, or oblique, which is not more than seven feet from the ground or floor, should be fenced by metal or wooden coverings. This should also be done with belting.

Gearing and cog-wheels should also be covered with a wire cage or some similar protection, while fly-wheels, water-wheels, and other parts of the machinery should be securely fenced.

Boilers used for generating steam should be thoroughly examined by an insurance company's engineer or other competent person at least once in every fourteen months.

4, Whitehall Place, London, S.W.,
November, 1906.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Onion Mildew (*Peronospora Schleideni*, Ung.).

This well-known disease occurs wherever the onion is cultivated. The first sign of the disease is the appearance of small, scattered, yellowish patches on the leaves. These patches gradually increase in size and blend with each other, until finally the entire leaf presents a sickly yellow appearance, and becomes thickly covered with a white powder. This has the appearance of hoar-frost, but soon changes to a dingy lilac colour. The powder consists of the spores of the fungus, the spores being produced in immense numbers, and soon infesting neighbouring plants. If a diseased leaf is examined with a good pocket-lens, the spores will be seen to be produced on branched threads which emerge through the stomata of the leaf, and form a miniature forest on its surface.

During the early stage of the disease the fungus exercises a very marked stimulating effect on the growth of the onion. This is shown by the rapid increase in length of that portion situated between the top of the bulb and the base of the leaves. This abnormally elongated portion is spoken of as the "neck," as shown in the accompanying figure. The presence of this "neck" is a certain sign of the existence of the disease. As the disease progresses all growth of the bulb is arrested, but the bulb itself is not attacked ; hence, if the fungus appears when the onions are fully grown, or nearly so, the crop is not destroyed. On the other hand, when attacked during the early stage of growth, as is usually the case, the crop is completely destroyed, unless preventive measures are applied.

Preventive Measures.

The disease in its epidemic form is entirely due to the particular kind of fungus-fruit described above which appears under the form of very fine powder on the leaves. This is quickly dispersed broadcast by wind or insects. As a rule, the disease spreads in the first instance from one or more centres, which are indicated by the yellowing of the leaves. If prompt measures are resorted to the disease can be held in check.

1.—All plants showing a trace of disease should be removed and burned, and the healthy surrounding plants, or preferably the entire crop, should be dredged with a mixture of powdered quicklime and sulphur, in the proportion of one of lime to two of sulphur. The dredging may be done by placing the mixture in a muslin bag and shaking it over the plants, or by specially made bellows or other contrivances now on the market. The work should be done when the plants are covered with dew.

2.—It is very important that, as far as practicable, every trace of diseased onions should be collected and burned, and not thrown on to the manure heap or into the piggery. If such are allowed to decay on the land, a recurrence of the disease is almost certain, as a second form of fungus-fruit is produced in the decaying tissues of the leaves. This fruit remains unchanged until the following season, or, if deeply buried, may remain so for several years, and when again brought to the surface in the ordinary routine of cultivation germination takes place, and if onions happen to form the crop, infection follows.

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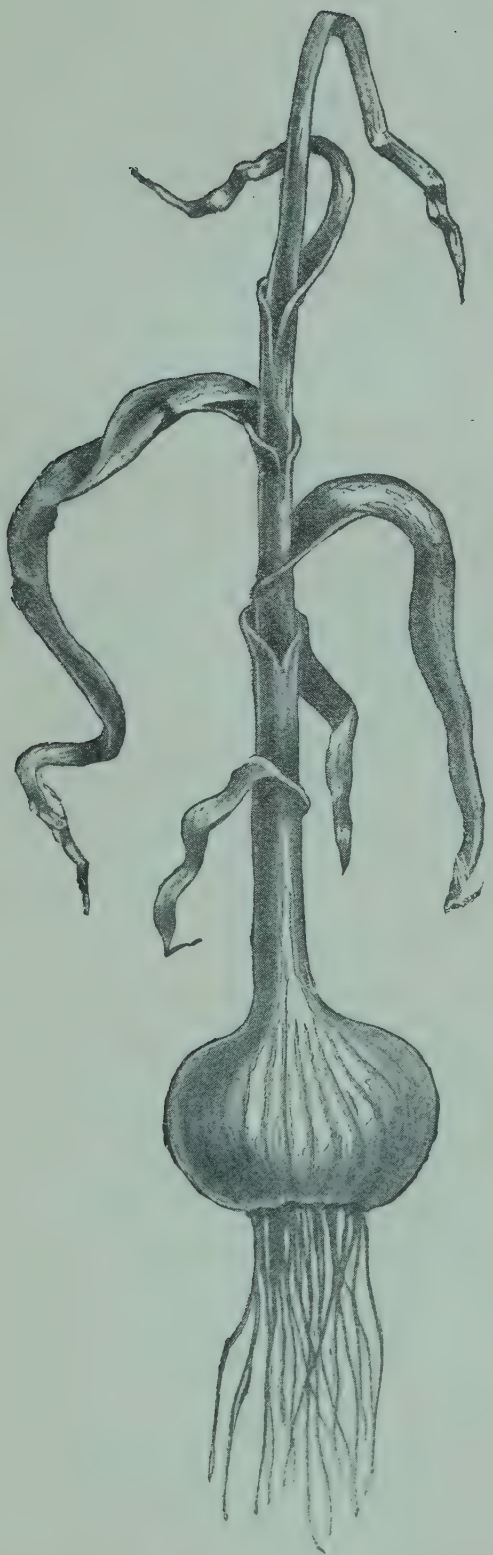

Onion Attacked by Mildew (*Peronospora Schleideni*, Ung.).

Leaflet No. 179.

BOARD OF AGRICULTURE AND FISHERIES.

The Making of Soft and Cream Cheeses and Clotted Cream.

Hard or pressed cheeses have for many generations been manufactured in this country, and are well known everywhere, but until recent years little has been heard concerning another type of cheese, properly called *soft cheese*.

No country has been so successful in the manufacture of soft cheeses as France, whence nearly all the delicate and refined varieties are obtained. To a certain extent the climate may be responsible for the great success of French cheese-makers, but given favourable conditions as to climate and locality, such as prevail in the south and south-western districts of England, and the presence in the dairies of the necessary moulds and bacteria, there is no reason why really good soft cheeses should not be made in Great Britain. It has, in fact, been proved that cheeses can be made equal in all respects to the best French produce, especially in the south Midlands and the south and west of England, districts which possess a moderately equable climate very similar to the soft cheese-making districts of France.

The production of soft cheese is especially to be recommended to small farmers and to others who have small quantities of milk available, particularly when they are situated near populous centres or watering-places in the southern parts of England. The demand for soft cheese in the north Midlands or northern districts of England is comparatively small.

Necessary Accommodation.

The chief obstacle in the way of the successful development of the soft cheese industry lies in the difficulty of controlling the ripening so as to make the produce uniform. Even in the localities where these cheeses are made in France the quality may vary greatly; hence it is necessary for the prospective cheese-maker to acquaint himself with the conditions desirable, the various rooms required, and the temperature at which each should be maintained.

In general, three rooms are necessary: (1) a *making room*, in which the milk is coagulated, drained, and formed into cheeses; (2) a *drying room*, where the cheeses undergo the first stages of ripening; and (3) a *ripening room* (or *cellar*), kept at a low temperature, in which the cheeses undergo the final process of ripening and refinement. The temperature, moistness of the atmosphere, and ventilation differ in each of these rooms, and unless the maker is fully acquainted with the conditions which should prevail in

each, his attempts at manufacture will almost certainly end in failure.

Fortunately, however, it is not difficult to adapt to the purpose of soft cheese making the buildings usually found in small homesteads. The *making room* need not be large, but should be provided with means for artificial heating so that the apartment can be kept at a constant temperature. The *drying room* should be in such a position and so constructed that the temperature and ventilation can be regulated at will. Thorough ventilation with means of controlling it is absolutely necessary in the drying room. The final *ripening room* should be moist, and not subject to any great variations in temperature.

General Description of Soft Cheeses.

The refined soft cheeses most popular are the Camembert and Brie. The Pont l'Évêque cheese is also well known, and though it is usually considered a soft cheese, the mode of manufacture and ripening differs somewhat from that of the true type of soft cheese, the ripening not being due to mould growth, but depending largely upon the enzymes of rennet, a comparatively large quantity of which is used in the coagulation of the milk.

It will be wise on the part of the maker to specialise in one variety of cheese only, as each variety described below requires a different degree of temperature, moisture, &c., in the different stages of manufacture.

As generally understood, soft cheeses are small, non-pressed, and quickly ripened, and are frequently so soft as to be spread upon bread like butter. Usually they are made from perfectly sweet milk, and development of acidity takes place in the milk after the rennet has been added, or in the curd whilst draining and before the application of salt. On the other hand, with the hard or pressed type of cheese the milk is partially soured or ripened before the addition of rennet, and all the acid necessary for securing the correct type of cheese is developed before the curd is salted or placed in the hoops or forms in which it is pressed.

Soft cheeses—though each variety may be made in a special manner—all agree in one particular, namely, that the whey is never fully drained from them. The coagulated milk, or "curd," is usually ladled into forms or metal hoops, and allowed to drain naturally. The cheeses are not subjected to heat or pressure, and consequently contain a much larger amount of water at the beginning of the ripening stage than do hard cheeses. As a consequence of this soft and moist condition they afford favourable conditions for the growth of various micro-organisms, and enzyme action occurs more readily than in the pressed or hard varieties of cheese.

The action of the fermentation agents ripens the cheeses rapidly and develops high flavours, as in the Camembert, Brie, and other varieties. Certain moulds which form readily upon the surface of these cheeses play an all-important part in the ripening process.

These moulds are aerobic, and the ripening propagates itself from the surface to the interior. The breaking-down or ripening of the curd is due in most cases to the production of unorganised ferments or enzymes, but the flavour, texture, and appearance of the curd are different for different varieties of cheese, depending largely upon the methods of treating the curd, the quality of the milk, and the conditions in the ripening rooms.

From the foregoing remarks it will be gathered that the ripening of soft cheeses is due to the presence of certain moulds and bacteria, and it is a fact that the maker never produces a Camembert or Brie cheese of correct texture or flavour unless he is able to grow upon the surface certain types of moulds. In the ripening of the cheeses the mycelium (or "roots") of these moulds penetrates to a short distance into the surface of the cheese and produces enzymes, or proteid digestive materials which gradually bring about changes of a digestive nature in the raw curd, this action being equivalent to ripening. In the true type of ripened soft cheese, such as Camembert, the ripening proceeds from the surface towards the centre. Beginning at the outside there appears a change of the hard raw curd into a softer buttery material, and if the cheeses are properly made this slowly extends to the centre, and in from three to five weeks the ripening process will be complete.

It is necessary for the luxuriant propagation of the desired moulds that the curd should at the outset be highly acid. Unless the curd is sufficiently acid or sour at the time of salting, the mould will never afterwards grow properly, but if the making room is kept at a sufficiently high temperature during the draining process, the cheeses are certain to attain to this condition before the application of salt, which to a great extent stops the development of acidity. The acidity should, however, be allowed to develop naturally. If starters of lactic-acid bacteria are used in soft cheese making—as in cheddar-making—the development of acidity will be too rapid during the first stages and the curd will drain quickly, becoming hard and dry, and will not contain sufficient moisture for the growth of the desired moulds. The only ripening material admissible in the manufacture of soft cheeses is a mixture of a little of the ripe cheese—which contains the spores of the moulds or fungi—with water or sweet whey, and this is introduced into the milk before renneting. (The preparation of this form of starter or inoculating material is dealt with on p 5.)

Camembert Cheese.

The Camembert is a French variety of cheese, and in its native country is usually made from whole milk of a quality similar to that given by Shorthorns; often, however, separated or perfectly sweet skimmed milk is mixed with the new in the proportion of 1 to 5. This cheese is usually made from September to May. During the summer months its manufacture should not be attempted, as the cheese does not then ripen properly. In summer the Camembert gets too soft, and has an offensive smell, and the demand in summer is for a soft cheese of a fresh or unripened type. The cheeses are small—about $4\frac{1}{2}$ ins. wide and $1\frac{1}{4}$ ins. thick—and weigh from 10 to 13 oz. About $5\frac{1}{2}$ gallons of mixed new and skim milk are required for each dozen cheeses. Camemberts are usually sold retail at 7*d.* or 8*d.* each, and the maker realises a really good price for the milk used in their manufacture.

The milk is received uncooled direct from the cow. Milk that has been cooled does not make good Camembert cheeses. If separated milk is added, it should be perfectly sweet and fresh, and free from froth. The milk is strained into wooden tubs provided with close-fitting lids; tubs of a correct size hold six gallons each. Metal vessels should not be used, or the outside portion of the curd will get chilled, and this chilled and soft curd causes irregularity in the cheeses afterwards. A six-gallon setting tub will hold sufficient milk to make two dozen cheeses if the two-curd system, which is the best, be employed. The cheeses are sometimes finished at one operation, but the two-curd system is preferable—half of the curd being filled into the moulds in the evening, and the other half the following morning.*

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* The two-curd system is considered preferable for the following reasons:—If made of two curds the cheeses drain better, and there is less loss through oozing of the curd from the forms or hoops There is also no need to wait for the curd to settle and chill before the hoop is completely filled. If the moulds are altogether filled at one operation the lower portion of the curd is subject to too much pressure, and irregularity in the moisture content of the cheese will ensue. Another most important point in favour of the two-curd system lies in the application of salt. It is necessary to salt these cheeses twice with an interval of six or eight hours between each salting. If the cheeses are made in two operations the lower or older portion is turned up and salted first, and by the time the salt has dissolved the newer surface will be ready to be salted and it will then be almost identical as regards age, acidity, etc., with the first-made curd, whereas if the cheese has been made of one curd only and an interval allowed between the salting of the two surfaces—which, if the salting is to be properly accomplished, is absolutely necessary—then it follows that the top and bottom will differ in acidity and one side of the cheese will ripen differently from the other. In cheeses made of one curd only it is often found that the later salted side fails to mould and ripen at all, because it has been too sour and draining has proceeded too far.

The milk is usually renneted at a temperature of from 80° to 82° F., and ½ c.c. of rennet of a standard brand per gallon of milk is added so as to produce perfect coagulation in from 2 to 2½ hours. The rennet should be mixed with six times its volume of water and be thoroughly stirred into the milk.

The milk is stirred gently and carefully at first to prevent the rising of the cream. If the cream be allowed to rise during coagulation it will show in streaks in the body of the cheese, and any of the creamy substance appearing on the surface of the cheese will fail to grow mould satisfactorily.

To introduce the proper moulds and ferments into the cheeses, and into the dairy where soft cheeses have not previously been made, it is advisable to inoculate the milk with what is termed a "starter," which is added before renneting.*

The curd when ready is ladled out into forms or hoops of metal 4½ ins. in diameter and 4½ ins. high. These hoops rest upon straw mats placed on an inclined and grooved draining-table, made in such a form that the whey readily drains away.

The ladle used should have a sharp cutting edge and go easily into the hoops. Before ladling out the curd it is well to pour a little warm water into each hoop, as this produces a better face upon the cheeses. The cheeses are then left overnight, twenty-four of the half-cheeses having been made from 5½ gallons of milk used. By morning they will have drained to about two-thirds of their original dimensions. In the morning a similar quantity of milk is taken and treated as described, but before ladling out the morning's curd the surface of the first portion of the cheese should be carefully broken up with a wooden spatula to admit of the two curds joining properly ; unless this be done, the cheese is liable to break in halves. In ladling out the morning's or second half of the curd, it is important that the last slices be placed upon the surface of the cheese in an unbroken condition ; to ensure this a little curd with which to finish the cheeses should be placed on one side at the outset.

The cheeses are now left to drain in a temperature of not less than 65° F., and when the two curds are approximately

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* This culture of the desired ferments, etc., is made as follows :—Take a small portion of curd, say ½ oz., from just below the crust of a really good half-ripe Camembert. Macerate this piece of curd and add it to half a pint of distilled water or sweet whey at a temperature of about 80° F. Stir occasionally until the curd has thoroughly dissolved and then strain into the milk from which the cheese will be made. Stir the milk for a while so that the ferments get properly distributed before the addition of rennet. This inoculation of the milk should be repeated for a few days or until the cheese rooms and utensils get thoroughly permeated with the ripening ferments. Afterwards if conditions are favourable the mould will make its appearance upon the cheeses naturally.

thirty-six and twenty-four hours old they should be more than half-way down the hoop and firm enough to admit of turning. The turning of the cheeses is rather a delicate operation, and requires much practice before it can be skilfully performed. The maker, deftly putting his left hand under the cheese without removing the hoop, inverts the whole, steadying the cheese meanwhile with his right hand and placing it face downwards upon a fresh straw mat. The upturned surface of the cheese should present an unbroken grooved appearance due to the straw upon which it has been resting. Sometimes the cheeses settle too rapidly. This is due to the milk being out of condition—a little sour, perhaps, or the making room may have been kept at too high a temperature. At other times the cheeses fail to drain or settle sufficiently ; when this is the case the temperature has usually been too low at renneting, or the temperature of the room may have been too low. Cheeses which drain slowly are usually fermented and spongy, the excess of moisture setting up abnormal fermentation. Such cheeses are never good. They are nearly always slimy on the outside, and a slimy cheese will never mould or ripen properly.

The salting of the cheese takes place when the curd has shrunk a little from the sides of the hoops, and the upper and older surface is salted first with fine dry salt spread evenly, about $\frac{1}{2}$ oz. being used for each cheese. After thus salting the upper face only, the cheeses are left for six to eight hours in the hoops, when the second salting takes place. The hoops are removed, and the cheeses turned and held in the palm of the left hand, salt being applied to the new upper surface and to the sides, the latter being rubbed heavily with salt. The cheeses should then be placed on sparred shelves in the making room and turned twice daily. When they begin to show the growth of a fine white, rather pilose or hairy mould, evenly distributed, they are removed to the drying room. Up to this stage all the processes have been carried out in the making room.

The drying room is an apartment with preferably a northern aspect, and so constructed as regards ventilation that currents of air can be directed upon the cheeses in all directions. Provision is made for artificial heating, and the ventilating slides and windows are so constructed that they can be opened and shut at will. The room should be kept at a temperature of from 54° to 56° F., and not be too dry. If the conditions are favourable the Camembert mould will grow rapidly, and in course of time blue tints will appear upon the extremities of the white mould, and the cheeses generally will assume a greyish-blue appearance. When this point is reached the cheeses must be removed to the cellar or cave. The object in bringing the cheeses into the first

ripening or drying room is to get a fairly dry surface, and also to facilitate the development of the fungi which exercise such an important part in the ripening process.

During the time the cheeses are in the drying room a great deal of attention and observation is necessary on the part of the maker. If the moulds do not grow freely or the cheeses shrink, then the atmosphere is too dry. If, on the other hand, the cheeses get greasy or points of dark green or black appear, then the temperature is either too low or the atmosphere too damp. In the drying room the sparred shelves should run down the middle and not be placed against the wall, and the cheeses are first placed on the top shelves and gradually lowered as they ripen, and new cheeses are brought in.

At the stage when the cheeses are removed to the cellar or ripening room they should feel soft and springy to the touch. The atmosphere of the cellar should be fairly damp and still, and little ventilation is required. The temperature should be maintained at about 50° F., and the cheeses should be turned daily. The shelves upon which the cheeses rest are covered with wheat straw, which is occasionally changed.

On removing the cheeses to the lower temperature of the cellar the growth of the moulds is greatly reduced, and largely ceases. The outsides assume a reddish-brown appearance, and the cheeses get a little sticky and glairy on the surface. This is an indication that the cheeses are ripe and ready for sale, for at this stage certain compounds are formed which give characteristic flavours to this type of cheese. If kept too long they will rapidly deteriorate and liquefy, and become unpalatable.

The cheeses are usually packed in lots of six and wrapped in straw, or they may be placed in the familiar wooden chip boxes and sent to market when about three-fourths ripe.

The mould growth on Camembert cheese is of the greatest importance, and if the colour appears in any different sequence to that described, then the cheeses will be inferior.

At first the cheeses should be covered with a pure white rather pilose mould, forming a layer of about one-eighth of an inch thick over the whole surface of the cheese. With the ripening of the spores of the mould the colour gradually changes to greyish-blue. This change becomes complete in about three weeks from the time of making, and no further mould-growth seems to take place afterwards. Finally, the mould breaks down and the brown-reddish condition of the surface appears, and at this stage the cheeses are considered ripe. In a well-made cheese, cut through the middle when ripe, the softening of the curd will extend to the centre, whereas a cheese badly made will show a layer of hard sour curd in the centre, while the outside portions will be in an almost liquid state.

Brie.

The Brie cheese is a very popular variety in France. It is softer and more creamy in texture than the Camembert, resembling a good cream cheese, but necessarily of different flavour.

It is larger than the Camembert, but the ripening process is similar, and it owes its distinctive flavour and qualities to the action of moulds which grow upon its surface. In the matter of curing rooms and method of manufacture, the requirements are very similar to those of the Camembert, though the temperatures at which the various rooms are kept vary somewhat.

The aim of the maker is to obtain a cheese which will ripen rapidly and regularly. The first point is chiefly a matter of manipulation, while the second depends upon the growth and development of certain types of moulds and ferments. In order that a cheese may ripen quickly, it must contain an excess of moisture and be non-coherent; to ensure this condition a slow coagulation of the milk is necessary, and this means the employment of a very small quantity of rennet ($\frac{1}{4}$ cc. per gallon) and the use of sweet milk.

The milk is usually brought direct from the cowsheds while retaining its animal heat, and the rennet is added at a temperature of from 82° to 86° F. About 14 lb. of milk are required to produce a cheese of standard size, and coagulation should be complete in about four hours.

When the curd is ready to be ladled out it should be shorter or less tough than in the case of the Camembert, and should have shrunk a little in the cheese-tub, to the extent at least that whey appears upon the surface. The hoops or cheese-moulds are usually $10\frac{1}{2}$ ins. in diameter by about 4 ins. in height, and the ladle for scooping out the curd is similar in shape to the old-fashioned cream-skimming dishes in use in many dairies. The moulds are laid singly upon straw mats resting upon boards, and the curd is placed in them in horizontal thin slices.

The best cheeses are made of two curds, as described in the manufacture of Camembert. When the two curds have sunk just below the rim of the lower mould, the upper ring is removed, the cheese is covered with a clean straw mat and a board, and reversed.

The cheese is again turned at the end of three or four hours, clean mats being used at each turning. It is essential that the mats be crossed at turning so that the marks of the straws show in cross section. This is important, as when the straws are crossed air is admitted more readily to the under surface and ripening is more regular. When the cheese is firm enough to admit of the hoop being removed, it is salted on the surface with fine dry salt, which should be spread very evenly upon the whole surface. After the

first salting the cheese is left for from eight to ten hours, and then turned on to a round osier mat termed a *clayette*. It is then again salted upon the now upper surface and the sides, and removed to a drying room which is kept at a temperature of from 63° to 65° F., to shelves so placed that gentle currents of air can be admitted over the surface of the cheeses. When placed in this drying room the cheese is solid and rather firm, but friable and very acid.

In the course of a day or two, if the cheese has been properly made, there should appear upon the surface a white fungus mycelium which grows rapidly in a warm and fairly moist atmosphere. With the best cheeses a reddish mould succeeds the white mould, though with many of the coarser cheeses a blue mould succeeds the white. The latter, though common, are not the true type, a cheese growing a red mould being always superior in quality.

When this red mould is well established on the cheeses, they are removed to the cellar or cave, where ripening is completed. If the cheeses are to be kept for any length of time they should be placed in a very cool dry cellar at an early stage in the ripening process.

It will be gathered that the method of manufacture of Brie is somewhat different from that of Camembert. The object of the maker is to conserve more moisture in the curd and to ripen in a shorter period. Hence coagulation of the milk is slower, and the temperature of the making room is lower. These two factors tend to slow and incomplete drainage during the first stages. After being properly formed and salted, the cheeses are placed in the second ripening room at a higher temperature, and this room is kept more moist than would be the case with Camembert. This tends to rapid growth of the moulds and quick ripening, and a soft texture in the cheese. In the cellar the temperature will vary, depending in a great measure on the period at which the maker wishes to dispose of the cheese.

The cheeses when ripe are usually cut up into diamond-shaped pieces, placed in boxes of the same shape, and retailed in this form. The price obtained is 1*s*. 6*d*. to 2*s*. for each cheese, the sections realising proportionately less.

Pont l'Évêque.

The cheese known as the Pont l'Évêque has acquired a considerable reputation in England, and though usually designated a soft cheese, it is of a type entirely different from the Camembert and Brie.

The ripening of this cheese is not dependent upon the growth of moulds, but is probably largely due to the enzymes of rennet introduced in a comparatively large quantity during the first stage of manufacture.

The cheeses are either square or oblong with "rounded corners." They are $1\frac{1}{4}$ ins. in thickness, and weigh about

1 lb. each. When ripe they present a brownish-red exterior, are pliant and yielding to the touch, and the peculiar flavour somewhat resembles that of a very fine soft Edam cheese, though more sweet to the taste.

In the manufacture of this cheese the lactic acid ferments play a very unimportant part. Indeed, it is the practice to rennet the milk and so handle the curd as to exclude as far as possible the action of lactic acid producing ferments. A milk at all acid or to which a lactic acid starter has been added is altogether unsuitable for the manufacture of Pont l'Évêque. If at all acid during the first stages of manufacture the cheeses dry and get hard quickly, and fail to take the salt. In the later stages they get hard and dry, and are of no value.

The Pont l'Évêque cheese is somewhat difficult to manufacture. The various mechanical processes are simple enough, but the whole secret of success depends on the ability of the maker to determine when the curd is ready to hoop. It may be said that very few English makers are really able to determine the exact stage at which to hoop the curd. If at this stage the curd is too hard and dry, the cheeses will drain inordinately and become hard ; whereas if the curd is too moist or has been chilled, the cheeses will contain an excess of moisture, and in the course of a few days will spread out into an unshapely mass in the curing room and become quite unpalatable.

The cheeses are rendered more difficult of successful manufacture by the very fact that acidity of the curd during the earlier stages is not admissible.

The method of manufacturing Pont l'Évêque is as follows : —About 50 lb. (for six cheeses) of perfectly fresh new milk should be strained into a wooden tub of 6 gallons capacity. If the milk has fallen to below 90° F., then it should be raised to this temperature or a little higher before rennet is added.

The usual setting temperature is from 90° to 94° F., and rennet of a good standard brand is added at the rate of one dram (mixed with six drams of water) to each 20 lb. or 2 gallons of milk. Many makers add a quart of boiling water to each 5 gallons of milk before putting in the rennet. This is good practice, as it tends to the production of a soft cheese. It will be observed that the proportion of rennet used is comparatively large, and this is necessary if the cheeses are to ripen properly, for, as already stated, the ripening is almost entirely due to the enzymes contained in the rennet.

After the addition of rennet the milk is stirred carefully at intervals for four or five minutes, and then covered up and kept as warm as possible. In from thirty to forty minutes coagulation will be firm and complete. At this stage the curd is cut vertically with a long knife into one-inch square

sections, which are then cut diagonally across. This cutting is done to ensure rapid drainage of the whey from the curd, and should be carefully and thoroughly performed. A sharp-edged skimming dish or flat scoop is now inserted about three-fourths of an inch deep, thus cutting the curd horizontally, and the curd is ladled out into warm straining cloths thrown over wooden forms resting on a draining-table. This operation should be done quickly and carefully, as it is necessary to keep up the temperature. When all the curd has been ladled out, the corners of the cloth should be brought together but not tied. The curd will drain more quickly if spread out in a thin layer, and the temperature can be kept up by the use of warm dry cloths spread over the surface. The cloths should be opened out and the curd moved at intervals, drainage being assisted in every way without injuring the quality of the curd.

If the curd has been properly handled, drainage should be complete in about thirty minutes, and the curd should then weigh about one-third of the original volume of milk. At this stage the curd is partly broken up with the fingers and carefully placed in the little metal hoops or moulds which rest in pairs upon straw mats spread over boards. The curd is taken in the fingers and pressed closely and firmly against the sides and bottom of the hoops so as to secure a smooth surface, and great care is necessary to finish the cheeses so that they present a close unbroken exterior. As soon as the moulds are filled they are turned in pairs upon other dry straw mats and boards, and this turning is repeated six or eight times during the first hour. The object of the cheese-maker should be to secure a close tight surface, as unless the surface is close the cheeses will lose moisture by excessive drainage and be spoiled.

The temperature of the making room should be kept at 65° or 68° F., and the cheeses should be ready to salt in from twelve to sixteen hours after the milk was renneted. The proper stage at which to salt is when the cheeses smell yeasty and are a little greasy upon the outside. Rapid digestive changes occur in these cheeses, and a knowledge of the exact stage at which to salt is important. In salting, the cheeses are lightly covered all over with salt, a little extra being added on the upper surface. Later they are turned and again salted in a similar manner.

The cheeses are kept in the making room for about three days, and are then taken to the curing cellar, which is kept at 58° to 60° F. They are laid on sparred shelves covered with wheat straw, and are occasionally washed with weak brine to prevent the formation of mould.

When the ripening process has proceeded for sixteen or eighteen days, the cheeses are packed together in layers of three to conserve moisture, and occasionally their position

is reversed in order to secure uniform ripening. The period of ripening usually extends to five or six weeks, and when the cheeses are ripe they should be soft, but not creamy. A good cheese will show a slight bulging of the sides, and when cut should be uniformly ripe throughout. In this respect it differs from the Camembert and Brie, which ripen gradually from the outside towards the centre.

When ripe the cheeses are packed singly in suitable chip boxes, and realise from 10*d.* to 1*s.* each retail. When properly made they are excellent, and are not so perishable as many other soft cheeses.

Gervais.

This is a popular variety of French cheese, made from a mixture of whole milk and thin cream, in the proportion of two to one. The Gervais is a small cheese, measuring about $2\frac{3}{4}$ in. high by $1\frac{3}{4}$ in. in diameter, and may be consumed either fresh or when some days old. The moulds for this variety of cheese consist of 12 small moulds fixed on one base. To produce 12 cheeses two quarts of warm new milk and one quart of cream should be mixed together by constantly stirring for at least 10 minutes. The temperature of the mixture should then be regulated to 60-65° F., and 1 c.c. of rennet (diluted with a little cold water) should be added. Provision should be made to keep the temperature uniform until coagulation is complete, this being in about 12 hours, when the curd may be ladled into a draining cloth of a suitable degree of coarseness and hung up to drain as in the case of cream cheese. When sufficiently firm it should be salted preparatory to moulding. The moulds should be lined with strips of blotting-paper, a special variety of which is made for this kind of cheese, and then set on a straw mat placed on a board. The moulds should be carefully filled with the curd by means of a bone knife. The curd should be left in the moulds for a short time until the cheeses have become fairly set, when the moulds may be removed. The cheeses may be placed in light boxes of beech wood for sending by post or rail. Though Gervais cheese is chiefly eaten fresh, it keeps well for several days after removal from the moulds, and some prefer it at this later stage of ripeness. Gervais should realise from 3*s.* to 4*s.* per dozen retail; the wholesale price is 2*s.* 6*d.* per dozen.

Cream Cheeses.

Cream cheeses are extensively manufactured in England during the summer months, but almost every dairy has its own particular method, and no really serious attempt appears to have been made to put upon the market cheeses of uniform quality and flavour.

In flavour the produce of different dairies varies widely, no two dairies being alike, and the flavour of the greater portion of the cheeses made is not good. Many makers appear to think that any sort of cream is good enough with which to make cream cheeses, but this is a mistake. If the cheeses are properly made with the best cream, no more profitable branch of dairying exists than the manufacture of cream cheeses.

Cream intended for cheese-making should be perfectly fresh and sweet to commence with, and any ripening necessary should be undertaken before the cream is placed to drain. The old method of draining the cream by hanging up in a bag or cloth for two or more days is a mistake, as by the time the cream has drained sufficiently it has assumed a bad flavour, which is reproduced in the cheese. In judging the cream-cheese classes at shows it is found that the flavour is at fault in 90 per cent. of the exhibits, and this is almost always due to the protracted period of drainage.

In general, two varieties of cream cheeses are manufactured—the one known as double-cream, from cream containing about 50 per cent. of fat, and the other from thin cream which is thickened with rennet before drainage takes place.

If it is required to make the sweet variety of cream cheese, the cream is drained afer standing twelve hours, but if a certain amount of ripening is desired, then a small quantity of starter (usually about half a pint to each gallon) is strained into the cream immediately the temperature has been reduced to 60° F.

This starter may be either a pure culture of lactic acid bacteria, such as is used by most cheese-makers, or it may be a little clean soured milk.

Double-Cream Cheese.—A really good method of making double-cream cheese may be described as follows :—

The cream is taken off thick, and if pasteurised will be so much the better. It is then cooled in cold running water till the temperature is down below 60° F., and is allowed to stand at this temperature for twelve hours.*

The cream is drained in fine linen or longcloth spread over a wooden form, and this form is provided with a loose board which can be weighted when necessary to press out the superfluous moisture.

The cream should be put to drain on a level slate or marble slab or table, and if it has been properly treated only skim milk should exude.

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* Thick cream cooled over a refrigerator does not make good cheese, the product tending to be coarse and open in texture. The proper method is to cool the cream in pails in cold running water. An interval of twelve hours between separation and drainage is necessary, as this develops the flavour and assists in after-drainage.

A form large enough to drain one gallon of cream at a time (for 32 ¼-lb. cheeses) will be 18 ins. long, 14 ins. wide, and 4 ins. deep. The pressing board should be 1½ ins. thick, and made of sycamore or canary wood. The fine cloth is thrown over the form and pressed down to the level of the table, and the cream then poured in to the depth of 1 or 1½ ins., covering the whole inner area of the form. The edges of the cloth are now turned over and neatly adjusted so as to cover the whole surface of the cream, the board is placed on, and left for half an hour with a 7 lb. weight on it. Drainage must be gentle at first, or the pores of the cloth get filled with cream. The cloth should be opened out once or twice during the first hour and the sides scraped down, when the cream should be re-weighted with a 14-lb. weight. If the cream is thick and has been properly cooled and prepared before drainage, it should be ready to mould in three or four hours from the time it was put to drain. It will have drained sufficiently when the curd weighs at the rate of 16 oz. to each pint of cream used. A small tinned-copper mould holding ¼ or ½ lb. is used, and, lined on the inside with a strip of parchment, it is placed in the centre of the muslin or paper wrapper and the cheese filled in with a wooden knife ; on removal of the mould the muslin or paper is wrapped round the cheese.

The cheeses are sold fresh or ripened, but it must always be remembered that cheeses made from fresh cream are perishable, and will not retain a nice sweet flavour for more than two or three days. Those who have a quick sale for their produce may venture to manufacture their cheeses from sweet cream, but if the cheeses are to be kept for any length of time, then the cream should be slightly soured before drainage. Lactic acid is a preservative, and tends to prolong the flavour and keeping qualities of most varieties of cheese.

It is, however, essential that the starter be of the right flavour, or the quality of the cheese will suffer. On no account should the cream be allowed to sour naturally, as by the time the cream has become sour the flavour will have suffered otherwise. Natural souring can be hastened by keeping the cream at a higher temperature, but such a procedure results in a greasy cheese, which rapidly becomes rancid. If it is necessary to salt the cheeses, the salt should be added to the cream, about 1 oz. to each gallon of cream usually being sufficient.

These cheeses realise 4*s.* 6*d.* per dozen wholesale, or 6*d.* each retail.

Single-Cream Cheese.—A very good cream cheese of poorer quality, but having more of a cheesy flavour, can be manufactured from cream containing from 25 to 30 per cent. of fat ; many persons prefer this type of cream cheese. About 24 ¼-lb.

cheeses are made from one gallon of such cream. In this case the cream must be cooled to 65° F., and three or four drops of rennet per gallon, together with a little starter, should be added immediately the cream is cooled, when the whole is left for eight or twelve hours before draining. If necessary, salt may be added to the cream at the same time as the rennet. With a cream that has been coagulated, it is necessary to use a ladle with which to lift out the curd into the cloth. The methods of draining, preparation and moulding are the same as those already described for double-cream cheese.

The single-cream cheeses can be sold at a lower price, as they contain a fair proportion of casein ; the wholesale price is usually 3*s.* 9*d.* per dozen, or 5*d.* each retail.

Cheeses of whatever quality will always be of uniform condition and flavour if made as described. The essentials necessary for the production of prime quality cream cheeses are :—(*a*) A sweet cream carefully cooled and prepared, and ripened at a low temperature ; (*b*) the addition of salt to the cream and not to the finished curd ; (*c*) the use of fine *dry* cloths in which to drain off the superfluous moisture ; (*d*) to have the cream spread out in a layer of not more than 1 or $1\frac{1}{2}$ ins. deep in the draining form ; (*e*) slight pressure during the first stages, increasing gradually to not more than 14 lb.

Neatly printed wrappers should also be used, and if the cheeses are sold wholesale they should be packed in wood pulp boxes holding half a dozen each. It must always be remembered that cream cheeses are particularly liable to become tainted, and hence care should be taken to have all cloths clean and draining forms and boxes made of materials that will not taint the cheeses.

Clotted or Scalded Cream.

Though originally confined to the counties of Cornwall and Devon, the manufacture of clotted cream is now carried out most successfully in practically all counties. In addition to its having gained a great reputation as a luxury, it is now largely recommended by the medical profession as an excellent fatty food, and is displacing to some extent the use of cod liver oil amongst invalids. Clotted cream is very rich, containing from 50 per cent. to over 60 per cent. of fat, and this fat is of a more digestible kind than any other, being present in the cream in a finely emulsified condition. In the preparation of clotted cream it is desirable to use rich milk, such as is produced from the Channel Island breeds of cattle, but this is not essential, and the evening's milk from Shorthorn cows will produce very good cream indeed. In Devon and Cornwall clotted cream is largely made from the milk of Devon cattle, which are admirably suited for the

purpose. Crosses with Channel Island cattle are also commonly employed.

Clotted cream is prepared as follows :—

1. Whole milk, warm from the cow, is carefully strained into setting pans. The pans most suitable for the purpose hold about six quarts of milk, measuring 15 in. across the top, 7 in. in depth, and 11 in. across the bottom ; they are similar to ordinary "shallow pans," but are somewhat deeper.

2. The pans of milk are left undisturbed in a cool dairy for the cream to rise. In summer, twelve hours or less is the time allowed, but in winter twenty-four hours is usual.

3. The pans should now be removed and scalded, great care being taken not to shake them and so disturb the cream on the surface. Scalding is carried out by placing the pans on a hot-water stove, and allowing steam to play under them until they have attained a temperature of 175° to 180° F. in not less than half an hour, when they are removed, and allowed to cool naturally in as cold a position as possible, as in a cellar. The scalding should not be done too quickly, otherwise the characteristic scald flavour is not produced and the cream is rendered greasy. The heating may be carried out by placing the pans on a kitchen range or hob, but the hot-water method is preferable.

4. When the scalded milk and cream are cold the cream may be taken off in a thick clotted condition, and is ready for sale. In summer it is especially advisable to cool the pans as quickly as possible after scalding, as this ensures extra keeping properties.

The cream is generally sold by the pound. One pound of cream may be obtained from 1½ gallons of Jersey milk, or less; whereas nearly 2 gallons of Shorthorn milk may be required to produce the same quantity of cream.

4, Whitehall Place, London, S.W.,
October, 1906.
Re-written, November, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 12 leaflets dealing with Farm Animals and Dairying may be obtained from the same address, price 1d., post free.

Leaflet No. 180.

BOARD OF AGRICULTURE AND FISHERIES.

Dodder.

The question to what extent the various species of dodder are harmful to agricultural crops is one which is of considerable interest to the farming community, and for some years past the agricultural press has contained many references to the prevalence of the pest in various districts. Moreover, in 1905, as much as 11 per cent. of the clover seed samples examined by the Botanist to the Royal Agricultural Society were condemned owing to the presence of dodder seeds, while two samples of red clover contained no less than 6 per cent. Some information, therefore, on the several species of dodder, the methods by which they are spread, and the best means by which they may be suppressed or avoided, may be of value to agriculturists and seed merchants alike.

Description of Certain Species of Dodder.

Some eighty species of dodder are known to science, and of these several occur in Britain. Dodder is botanically included in the order *Convolvulaceæ* under the genus *Cuscuta*. The dodder plant is an annual, growing from seed either self-sown or sown with other seed, and it is parasitic on other plants of a higher order, germination, however, taking place in the soil. Four species or varieties are mentioned in Hooker's Flora of the British Islands, these being *Cuscuta europaea*, *C. Epilinum*, *C. Epithymum*, and *C. Trifolii*, the most important being *C. Trifolii*. Other species, however, which have been introduced with imported clover and other seeds, may cause much damage in European countries, these species being *C. corymbosa* (of American origin), *C. Gronovii* (also American), and *C. monogyna*. All species are parasitic on other plants, and all have the same method of reproduction.

Cuscuta Trifolii, Bab.—This species (Pl. I.), significantly termed "clover dodder," and, according to Hooker, a variety of *C. Epithymum*, Murr., is the species commonly met with. It chiefly attacks red clover and lucerne. After a seed has once germinated the seedling quickly dies unless a clover or other suitable plant be at hand. Once established on a plant, however, it sends out roots or suckers (haustoria), which take firm hold of the host, loses its connection with the soil, and thereafter, unless checked, will rapidly spread in all directions by means of its slender, thread-like stems, which twine round the plants from which the pest draws its sustenance. *C. Trifolii* is quite leafless, but produces clusters

PLATE J.

of small white bell-shaped flowers, each of which yields a two-celled capsule. Each cell contains two seeds, a single flower, therefore, producing four.

C. Epithymum, Murr.—The flowers of this species are variable in colour, and about $\frac{1}{4}$ to $\frac{3}{4}$ in. in diameter, opening from July to October. The stems are reddish in colour and very slender. It occurs in Britain from Ayr southwards. It is also termed *C. minor*, Lam., or lesser dodder.

C. europaea, L.—In this species the stems are reddish or yellow in colour, and as thick as twine, the flower-heads being from $\frac{1}{2}$ to $\frac{3}{4}$ in. in diameter, and tinged with red. Flowering takes place in Britain during the summer months, the species being found from York to Sussex and Devon ; it is, however, rather rare in Britain. This species is also known as *C. major*, Lam., or greater dodder.

C. Epilinum, Weihe.—This species, flax dodder (Pl. II.), occurs sporadically on flax in Great Britain and Ireland, and is distributed throughout Europe. It is as large as the last species, but is paler and more succulent. It flowers during summer.

C. Gronovii, Willd.—This parasite, known as large American dodder, was identified in France by M. Schribaux some twenty-five years ago, when it appears first to have been introduced into that country from Canada or the United States. Owing to the fact that the seeds are about the same size as those of lucerne, they are with difficulty separated therefrom, and this renders the pest more dangerous. It is believed that this species does not ripen its seeds in this country, but the seeds germinate when sown, and produce dodder plants which are quite able to kill their host plant.

C. monogyna, Vahl., and *C. corymbosa*, Choisy (*C. Hassiaca*, Pfeiffer, or *C. suaveolens*, Seringe), are also harmful to certain plants. The latter is of American origin, and bears large seeds.

Description of Dodder Seeds.

The seeds of most species of dodder are very small—usually much smaller than the seed of red clover—roundish, and angled. It may be stated that they are generally smaller than the seeds of the plants on which they are parasitic. Exception must be made, however, in the case of large American dodder, *C. Gronovii*, which is much larger than the seed of most species. The seeds of *C. Trifolii* are roundish, about 1 mm. in diameter, dull in appearance, and grey, brown, olive-brown, or yellowish-brown in colour. In the case of *C. Epithymum* the seed is round-oval in shape, and yellowish-brown in colour.

Dodder seeds can soon be recognized with a little practice but cannot be certainly identified without the aid of a pocket-lens, or a slightly enlarging microscope.

Life History.

The embryo of the dodder seed is simple and thread-like, and coiled spirally round the fleshy albumen, while the radicle is thickened. The seeds seem to germinate best during damp seasons. At a suitable temperature they will germinate in five to eight days. When a seed germinates the thread-like coil unwinds gradually, the radicle end taking root in the soil, the remainder meanwhile lengthening and when it reaches a suitable host commencing to twine itself round the stem, to which it attaches itself firmly by means of the suckers or haustoria. (Should the thread-like stems fail to reach a suitable host plant, they die.)

The plant now extends its thread-like stems to neighbouring plants, and large patches may rapidly become infested and overcome, the dodder soon leaving its hold of the soil, and living wholly on the host plant. On becoming firmly established the dodder grows and spreads rapidly, produces flowers, and, if nothing be done to prevent it, seeds are formed and the soil is re-sown. Small fragments of the stems, constituting veritable cuttings, may suffice to establish new centres of infestation, attaching themselves to fresh plants. M. Marre states that dodder may also be spread by means of little tubercles, which are formed in winter.

As stated above, however, dodders are annual seed-producing plants, and are no doubt chiefly distributed by seed included amongst agricultural seeds.

As regards the life-history and manner of growth, the various species closely resemble one another. The harm done is best explained by stating that dodder possesses no chloroplasts, and is unable to take up carbon dioxide from the air like ordinary green plants, but after leaving its hold of the soil, it depends entirely for its food material on the ready-made products which it absorbs from its host plant, which may therefore become exhausted and die. So rapidly does the pest spread that it has been stated that in three months a single stem may kill all the clover or lucerne plants on an area of twenty-eight square metres (thirty square yards nearly), and so complete is the destruction that one would say a fire had passed over the spot. Infested plants may be said to present the appearance of being wound about with reddish or yellow threads.

Plants Attacked.

The cultivated crops attacked by the various species of dodder are numerous, the most important, however, being clover and lucerne.

C. Trifolii.—This variety is that which is most commonly found on clover and lucerne in Great Britain. According to Frank, however, it has been found on vetches, lupines, potatoes, beet, carrots, fennel, aniseed; not infrequently the

PLATE II.

wild species *C. Epithymum*, of which *C. Trifolii* is a variety, is found in meadows and pastures, on heaths. &c. M. Marre cites also *Lotus corniculatus*, lavender and other labiates, St. John's wort, species of heaths, *Achillea Millefolium*, and even (according to Prillieux) such graminaceous plants as ryegrass, as having been noticed attacked by this species. He observes, however, that very probably in some cases the dodder is merely entwined round the plants, and not attached to them by means of its suckers. *C. Epithymum* is also found on furze, thyme, and ling.

C. europaea.—In Britain, this species is found on vetches, nettles, &c. In France, it is recorded as living on hops, hemp, vetches, potatoes, the vine, acacia, poplar, aconite, and other plants.

C. Epilinum.—Known as flax dodder; this species chiefly attacks flax, but on the Continent it is found also on hemp and *Camelina.*

C. Gronovii.—Besides attacking lucerne, and without doubt other leguminous plants, it is stated to infest chicory, potatoes, and beet.

C. monogyna infests vines and some other plants; and *C. corymbosa* not only develops on lucerne but on various other leguminous plants.

Prevention and Remedy.

1. As it is so harmful when once established it is very important that dodder should not be allowed to obtain a footing on clean farms. This is undoubtedly only rendered certain by taking great pains that no seed is sown in which there is any trace of dodder. Bearing this in mind the purchaser should only deal with reliable firms, and should always insist, among other things, on a guarantee that all his seed is absolutely free from dodder.

2. If the purchaser is not satisfied as to the purity of any seeds he may have purchased an excellent plan is to sift clover and lucerne seeds, using a sieve of twenty meshes to the inch. Although the seeds of large American dodder are not removable in this manner, those of other dodders are separated with comparative ease. According to Nobbe's experiments, however, this method is not always entirely satisfactory owing to variations in the size of the clover and dodder seeds. In the case of white clover, for instance, the seeds may approximate in size to those of dodder. To make a cheap serviceable sieve for the purpose a light wooden frame may be constructed about 12 inches square and 3 inches deep, over the bottom of which a 20-mesh wire screen (made of No. 32 English gauge, round wire) should be tacked. In this one-fourth to one-half a pound of seed may be placed at a time and vigorously shaken for half a minute. A man should be able to deal with from 5 to 10

bushels per day. It may be remarked that where much seed is to be dealt with a larger sieve would be more useful.

3. In the case of all seeds the purchaser will be well-advised to consider the question of submitting samples to some authority for expert examination and approval.

4. Where dodder is found infesting a crop, however small the patch, steps should at once be taken to destroy it. This may best be done by digging up the infested plants and burning the whole, *in situ*, by covering the area 6 to 9 inches thick with long chaff, sprinkling it with paraffin, and then firing it. It is wise not to remove the infested plants for burning, as small pieces left on the field or dropped in fresh places may only serve to spread the pest. It is better to lose completely a small area of the crop by burning than to take risks and possibly have a much more serious infestation another year, especially since dodder seed may lie dormant in the soil for five or six years.

5. An infested field should not be allowed for a few years to carry a clover, lucerne, or other leguminous crop.

6. Thaer recommends that the infested spot be surrounded by a small trench at a suitable distance from the outermost threads of dodder, the soil removed from the trench being thrown on the infested spot. This method, or burning with straw, he considers to be better than the employment of corrosive substances, sulphate of iron, large quantities of superphosphate, or the refuse liquor from the manufacture of sulphate of ammonia, all of which work certain destruction to dodder. Such substances, however, ruin the soil for one or more years after use.

7. Tearing out the dodder with a rake is to be condemned, as this only serves to spread the evil.

8. Infested clover or lucerne should not be fed to stock, as the seeds may pass through the alimentary canal unaffected, and Frank mentions a case in which a field was actually infected by means of manure from young cattle, which had been fed on rape and linseed cake containing dodder seed the germinating capacity of which had not been destroyed.

9. Frank suggests that substances which will smother the dodder may be effectually employed, such as a layer three inches deep of chaff, tan or gypsum, covered with an inch or so of fine soil and saturated with liquid manure or sprinkled with powdered quicklime in winter. The clover will generally break through such coverings but the dodder will be unable to do so.

10. In cases where the infestation is very extensive, covering the larger part of the crop, it is perhaps better to plough the whole under before seeds are formed.

11. Above all, *good cultivation* in the widest sense should prevail, and all fields, hedges and ditches should be kept clean and free from weeds.

12. Spraying with a solution of sulphate of iron has proved successful in Germany. In August, 1906, a plot of red clover on which *Cuscuta arvensis* (an American species) had developed luxuriantly was sprayed with an 18 per cent. solution of sulphate of iron. The clover became so black that one might have thought it was ruined. After a short time, however, it sprouted again, and grew at least as well as the portion which was left unsprayed. The latter was ultimately still more checked in its growth by the spreading dodder. The dodder entirely disappeared from the sprayed plot, though it afterwards made its appearance to a small extent in consequence of fresh infection from the adjacent plot.

In 1905, however, infested clover did not recover after the application of an 18 per cent. solution, and Dr. Hiltner thinks it unnecessary to exceed a strength of 15 per cent. The spraying must be done with a sprayer, so that the liquid falls with some force on the ground. An application with a watering-can did not prove successful.

NOTE.—It may perhaps be stated generally that clover seeds are imported into Great Britain from nearly all parts of the world, particularly Germany, France, Austria, Russia, Chile, the United States, and Canada. Seed from nearly all these countries contains more or less dodder, which is, however, hardly known in seed from the United States and Canada. English-grown seed also rarely contains dodder. Some particularly fine samples of clover seed have lately been exported to Great Britain from New Zealand. These samples are clean and of the best quality, and appear to be generally free from dodder.

Lucerne is chiefly imported from France and the United States, but in much larger quantities from the former. The plant, too, from French seed is altogether superior to the American. Lucerne from these countries hardly ever contains dodder.

Description of Plates.

Plate I.—(1) *C. Trifolii* on Red Clover (*Trifolium pratense*); (2) flower; (3) section of calyx with pistil; (4) corolla laid open.

Plate II.—(1) *C. epilinum* on Flax (*Linum usitatissimum*); (2), (3) and (4) as in Plate I.

4, Whitehall Place, London, S.W.,
January, 1907.

Revised, August, 1908.

Leaflet No. 181.

BOARD OF AGRICULTURE AND FISHERIES.

Cleansing of Water Courses.

The attention of the Board has been drawn to the damage stated to be caused by the neglect of certain occupiers of land to keep clean the channels of water-courses and streams running through their land. It has been suggested that the law which deals with this subject is very little known, and the Board consider that it will be useful to publish, in the form of a leaflet, a short summary of the legal position.

For mere omission a man is not, generally speaking, answerable by law; and accordingly, at common law, the occupier of land through which a water-course runs is not, as a rule, under any obligation to neighbours whose lands drain into that water-course to prevent or remove any obstruction of the outfall due to merely natural causes (such as silting up of the channel or growth of weeds), and not caused by any action on his part, though, in exceptional cases, *e.g.*, under an inclosure award, such an obligation may sometimes exist.

A statutory remedy is, however, provided by the Land Drainage Act, 1847 (10 & 11 Vict. c. 38), and it appears to be applicable irrespective of any existing legal obligation on the part of the occupier of the land; but the statutory duty imposed by this Act arises only on notice given by the person injured, and the Act does not create any statutory liability in damages for the injury caused by the occupier's neglect.

Section 14 of the Act enacts that where, by the neglect of any occupier to maintain or join in maintaining the banks, or to cleanse and scour or join in cleansing and scouring the channels of existing drains, streams, or water-courses lying in or bounding the lands of such occupier, injury is caused to any other land, the proprietor or occupier of any land so injured may serve a notice on the neglecting occupier requiring him to maintain the banks or cleanse or scour the channels in question. If he neglects so to do, the occupier of the land injured may, after one calendar month from the service of the notice, carry out the necessary work. The cost of the same or a just proportion thereof is to be paid by the neglecting occupier, and payment may be enforced by an order of justices.

Section 15 provides that, unless the drain, stream or watercourse to be cleansed bounds or immediately adjoins the land of the occupier injured by the neglect, a justices' warrant to enter on the defaulter's land in order to carry out the necessary works must be obtained. This warrant is to be granted if the justices are satisfied that the injury has been caused by the neglect of the occupier whose land is to be entered.

The effect of these provisions was discussed in the case of *Finch* v. *Bannister* (L.R. 1908–2 K.B. 441 ; 77 L.J.K.B. 718; 99 L.T. 228) where it was held that they are confined to injury done to the land itself, and that they did not apply where the injury complained of was injury to a mill.

4, Whitehall Place, London, S.W.,
December, 1906.
Revised, August, 1909.

(*This leaflet does not apply to Scotland.*)

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 182.

BOARD OF AGRICULTURE AND FISHERIES.

Crimson Clover (*Trifolium incarnatum*).

While there are several species of plants belonging to the genus *Trifolium* the generic name is commonly applied to Italian or Crimson Clover, the term "Trifolium" being used among seed merchants at Mark Lane and in country markets, and also among the farming community.

Crimson Clover was introduced into this country as a field crop early in the nineteenth century, but previous to its introduction for such a purpose it was highly valued as an ornamental and showy border plant.

Owing to its peculiar climatic requirements Crimson Clover (Fig. 1) is most successfully grown in the Southern counties of England, where it is usually cultivated as a catch crop. It is an erect-growing annual from one to two feet high, and its habit of growth, hairy appearance, and bright crimson, oblong flower-heads are sufficient to distinguish it from all other species of the same genus.

In districts and soils suited to its growth, farmers seldom omit to lay down a certain breadth of Trifolium. The inducement to do so is apparent when one takes note of the economy of its cultivation and the rapidity of its growth, resulting in an early bite for stock, or in a crop which can be cut for horses and cattle at a period when green food is scarce.

The maximum yield of Trifolium is only obtained on warm, loamy, and gravelly soils. On colder land and in later districts it is sown much less frequently, as autumn rains and winter frosts prevent anything like successful results. As soon as the corn crop is removed, the cultivation for this clover should be immediately taken in hand. The preparation for the reception of the seed merely consists in working the surface with heavy drag harrows, so that the necessary tilth for covering the seed may be obtained without loosening the soil to too great a depth. The seeds are sown on the scarified surface, harrowed with seed harrows, and firmly rolled in. It is absolutely essential to its successful growth that the seed should be sown on a firm and solid bottom. If failure results it is more often than not caused by lack of firmness, and even on soils of a rather heavy nature, when ploughing is resorted to, the growth is not quite so successful as when the harrow only is employed.

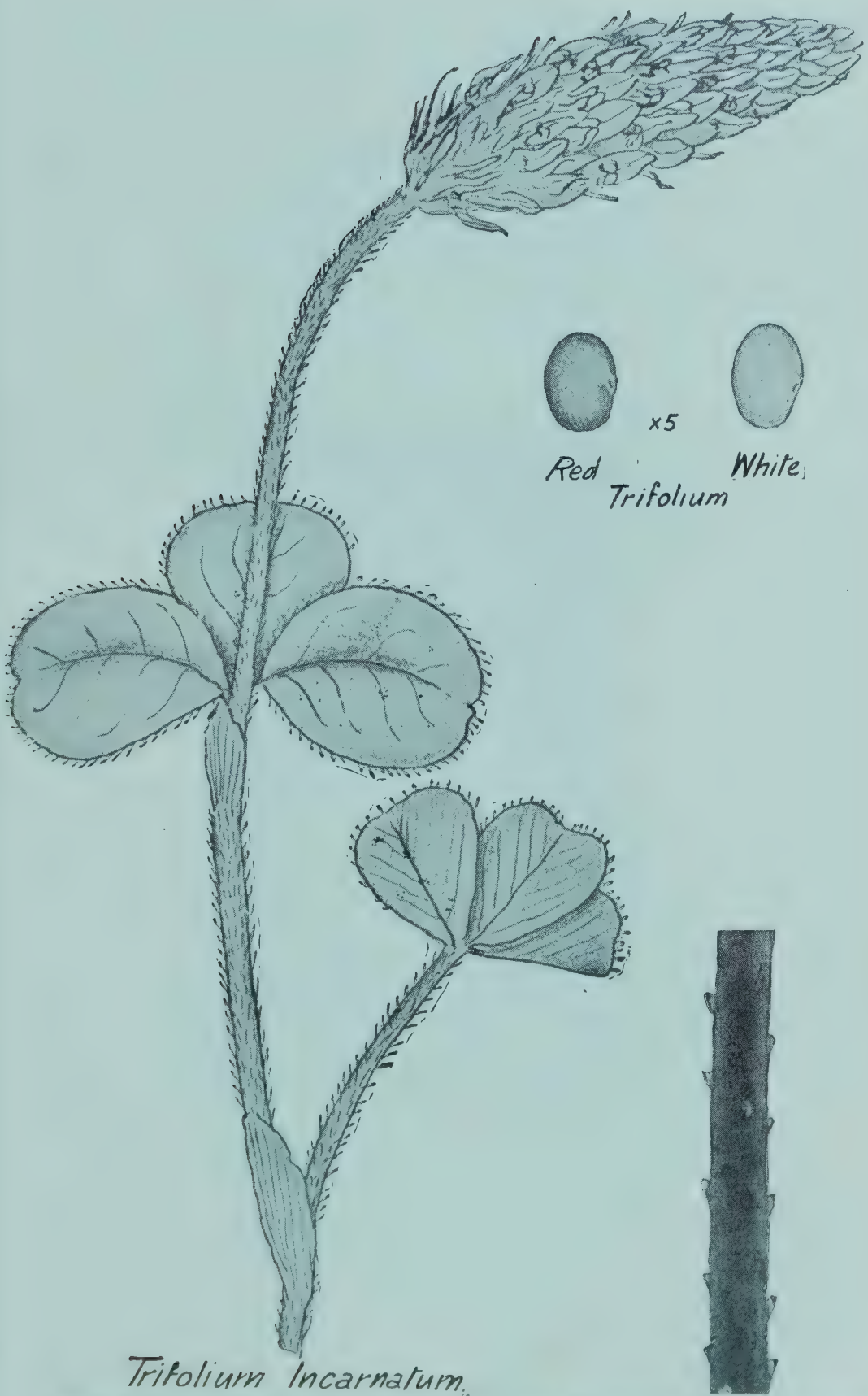

FIG. 1.—TRIFOLIUM INCARNATUM, WITH SEED.

FIG. 2.—SINGLE HAIR, SHOWING ITS SPINY OR BARBED CHARACTER, (magnified 300 diameters).

When sown in August as described, at the rate of 15 to 25 lb. of seed per acre, crimson clover grows rapidly, becomes well established and firmly rooted, so as readily to withstand the severity of the winter, and will yield a large crop, to be cut or fed off in the following May or June. The exact quantity of seed to be sown is somewhat dependent on whether the conditions for successful growth are favourable or otherwise. The larger quantity would of necessity have to be used should the conditions of climate or soil be adverse. If a time may be stated during which this useful plant should be sown, it might be given as ranging from the first week in August until about the 10th of September, and, as a general rule, the earlier the better.

FIG. 3.—FLORET OF CRIMSON CLOVER (magnified five diameters).

There are, at least, three varieties of Trifolium in commerce: early, medium, and late, as well as the white-flowered variety. They are all useful plants. In practice, it is usually desirable to sow a certain breadth of each; and, though sown at the same time, these varieties come into use at different times in the spring, thus producing a useful succession of food. When the ordinary clovers are seriously affected by the drought of summer, or weakened or killed by severe winter frosts, the bare spots may be successfully renovated by sowing a few pounds of Trifolium.

As a hay crop Trifolium is not successful, for it is usually more stemmy than leafy; but if it is to be made into hay it should be cut directly the flower-head appears, for, as the

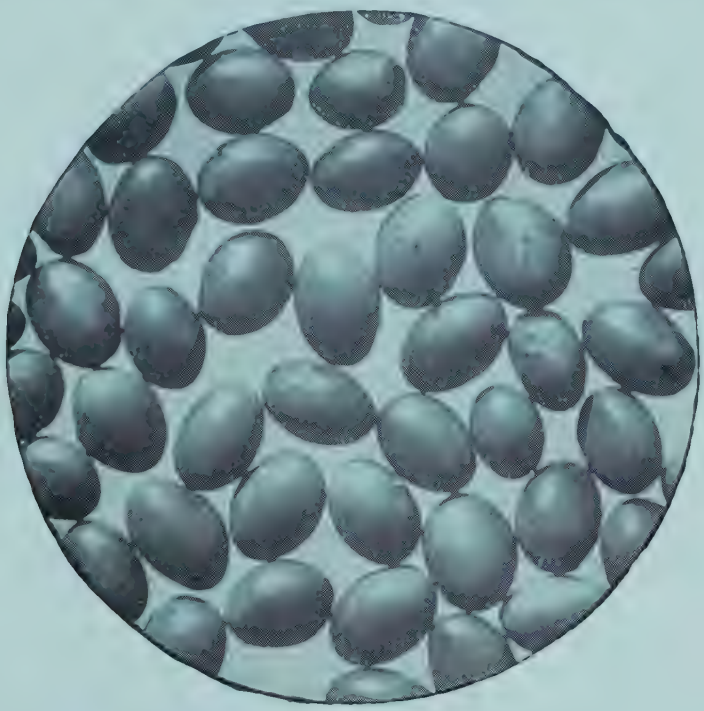

FIG. 4.—SEED OF CRIMSON CLOVER (magnified five diameters).

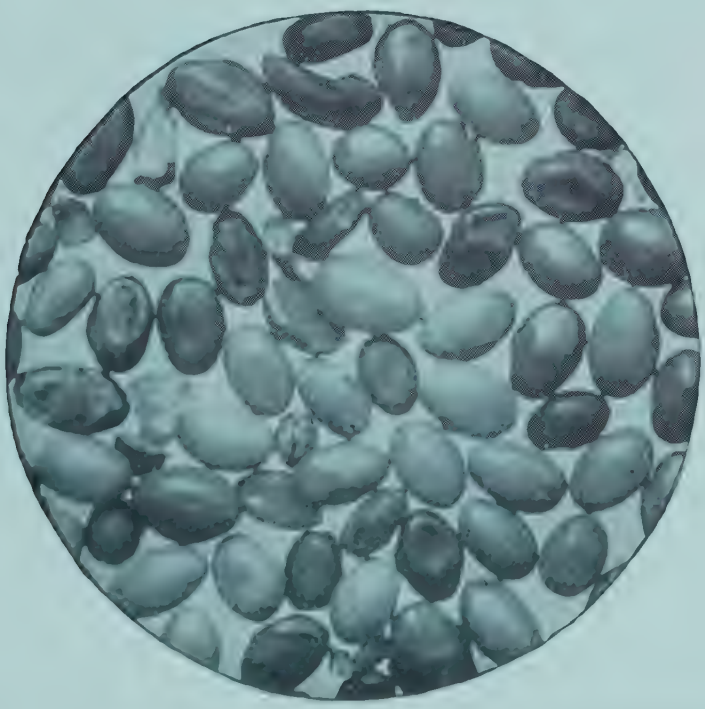

FIG. 5.—LOW-GRADE SAMPLE OF CRIMSON CLOVER SEED (magnified five diameters).

plant reaches maturity, the stem gets tough and woody, and serious danger to live stock consuming it may be apprehended.

Some idea of the danger following the feeding of mature Trifolium may be gathered from observing closely some of the micro-photographs illustrating this leaflet. Fig. 3 illustrates a single mature floret, five times life size. The whole of the flower-head from which the floret was taken was a little over three inches long, and its extreme hairiness can be imagined, as it contained 172 florets similar to that figured.

Hair balls removed from the intestines of sheep and horses have, by causing an obstruction, resulted in the death of the animal concerned, and have been found to be due to feeding with mature Trifolium. The hair balls have the appearance of a lump of smooth dried clay, but they are extremely light, and, when closely examined, are found to be composed of minute hairs. These hairs, when viewed under the microscope, prove to be identical with the hairs of the mature flower-head of Trifolium. They are serrated or barbed (see Fig. 2), and in consequence of the movement of the food in the stomach, become felted and form balls.

Crimson Clover, therefore, should never be fed to stock after the crop has ceased flowering, while the straw of Crimson Clover, raised and thrashed as a seed crop, should never be employed as a fodder.

Description of Seed.

The seeds of *Trifolium incarnatum* are quite distinct, both in colour, size, and shape, from other species of closely related *Leguminosæ*. Seeds recently harvested and in good condition are of a yellowish colour, somewhat tinged with red, or varying from a light to a reddish yellow, oval or elliptical in shape, and when fresh and new are bright and polished, with a smooth surface, and very much larger than the seeds of Red Clover. In the micro-photograph of a group of the seeds of Crimson Clover the uniformity of shape and size of grain in a good sample is well shown (Fig. 4). A very poor, low quality sample is also illustrated (Fig. 5), where the great variation in the colour and uniformity of the seeds is noticeable. Good commercial seed should be at least 95 per cent. pure, and there is no difficulty in obtaining seed having a purity of 98 per cent. The germinating capacity of fresh new seed of good quality rarely falls below 90 to 95 per cent.

The seed of White Trifolium, although larger in size than the red, is less uniform, both in shape and size. It is very easily recognised by its shape and colour, for, instead of being yellow tinged with red, it is of a bright cream white. In many samples the lack of lustre, combined with darkening of colour, is, in a great measure, sufficient evidence that advancing age has robbed the once living and robust germ of its vitality.

Impurities found in Trifolium Seed.

Some of the impurities found in Trifolium samples are shown magnified to the same scale, viz., five diameters in each case. Those illustrated are two species of Crane's-bill

FIG. 6.—GERANIUM DISSECTUM.

FIG. 7.—GERANIUM MOLLE.

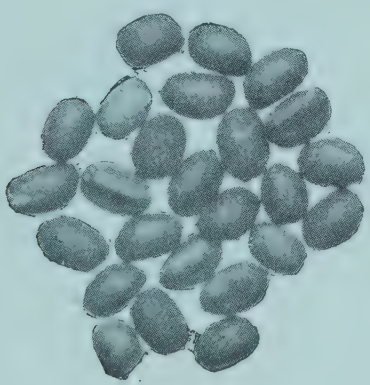

FIG. 8.—GERANIUM MOLLE (without husk).

FIG. 9.—FIELD MADDER.

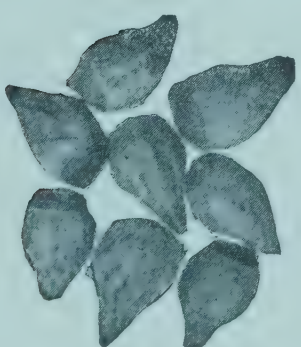

FIG. 10.—CORN GROMWELL.

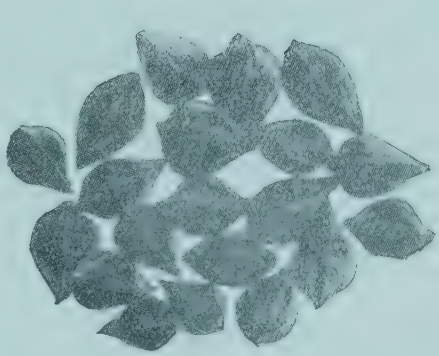

FIG. 11.—CURLED DOCK.

WEED SEEDS FOUND IN IMPURE SAMPLES OF TRIFOLIUM SEED (all magnified five diameters).

(*Geranium dissectum* and *Geranium molle*) (Figs. 6, 7, and 8), Field Madder (*Sherardia arvensis*) (Fig. 9), Corn Gromwell (*Lithospermum arvense*) (Fig. 10), and Curled Dock (*Rumex crispus*) (Fig. 11).

Samples of Trifolium seed that lack lustre usually contain a considerable proportion of immature grains, and, in consequence, the germinating energy is weak, the total vitality being below the standard of good marketable seed.

4, Whitehall Place, London, S.W.,
November, 1906.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained, free of charge, and post free, on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Sycamore Leaf Blotch (*Rhytisma acerinum*, Fries.).

Rhytisma acerinum ON SYCAMORE.

The conspicuous black spots, resembling blotches of pitch, which are so common on living leaves of the sycamore and maple, are probably familiar to everyone, although not always associated with the work of a parasitic fungus. These blotches, however, are due to the fungus *Rhytisma acerinum*, Fries., the damage done by which is not generally recognised.

Description and Life History.

Towards the end of June, small yellowish patches appear on infected leaves ; these patches increase in size until they are half an inch or more in diameter, and gradually darken in colour, until finally they become almost jet-black, with a border of dingy yellow. The substance of a fully-formed patch is much thicker than that of the leaf proper, owing to a crust formed by the fungus. The surface of the patch is wrinkled or corrugated, and, during the summer, produces myriads of very minute spore-like bodies the function of

which is unknown. They have not been seen to germinate, and seem incapable of causing infection. During the following spring, after the dead leaves have been lying on the ground throughout the winter, spores of another kind are produced in the substance of the black patches. These spores escape into the air through gaping cracks, and if they happen to alight on suitable young leaves, infection follows.

A second fungus, *Rhytisma punctatum*, Fries., also forms large black blotches on living leaves of sycamore and maple; it is distinguished by the black patch not being continuous, but composed of numerous minute distinct black spots, crowded together on a yellowish groundwork. The two species of fungi are not infrequently present on the same leaf.

Damage Done.

When the disease is present, almost every leaf on the tree is usually infected, and consequently a considerable amount of leaf surface is prevented from doing its work; and, in addition, diseased leaves fall early in the season. As the disease, unless checked, continues from year to year, the tree becomes enfeebled through lack of food, and then becomes an easy prey to a yet more destructive parasite, the Coral Spot fungus, *Nectria cinnabarina* (*See* Leaflet No. 115, Coral Spot Disease), which almost invariably follows an epidemic of leaf blotch.

Prevention.

The method for preventing a continuance of this disease is both simple and effective. As already stated, the young leaves are infected in spring by floating spores which escape at that season from dead leaves which have been lying on the ground during the winter. If all such dead leaves are collected and burned directly they fall in the autumn, or at latest before the young leaves unfold in the spring, the disease will be arrested.

4, Whitehall Place, London, S.W.,
August, 1907.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

RED, WHITE, AND ALSIKE CLOVERS

Red Clover (*Trifolium pratense*).

Two leaflets already issued* deal with Lucerne and Crimson Clover or Trifolium, and in the present leaflet it is proposed to give some account of three further leguminous crops which are of very great value to farmers. The differences between the seeds and the impurities found in samples of the different species are also given, as being of considerable importance.

Red clover takes high rank among fodder plants, not only on account of the quantity but of the quality of its produce. It is, perhaps, the most common and widely distributed of all the clovers. Several varieties are indigenous to this country, but only the two which are commonly sold as red clover and cow grass will be discussed here.

Red clover is largely used in alternate husbandry ; in the south of England it is chiefly grown as a pure crop, while in the north and also in moister districts of the country it is largely sown with Italian rye grass for a one year's ley, or with a mixture of grasses for a two or three years' ley. When used alone, about 14 lbs. of seed are usually sown, and in mixtures various proportions are employed, the smaller quantities being used for leys of longer duration. It grows freely upon practically all soils except those which are either very wet or very dry, but thrives best and for longer periods upon rich, deep, heavy loams, particularly when these contain a fair supply of lime. It yields the heaviest crop during the first year but on suitable soils continues to grow a second or even a third year. Remunerative crops cannot be grown frequently upon the same land ; usually four years, and often a much longer period, must elapse after a red clover crop, whether grown as a pure crop or in a mixture, before the soil is capable of again yielding a good crop of it. Land which is thus unable to produce clover is said to be *clover-sick*. On such land a good plant of clover may often be obtained, but during the period from October to March most of the plants disappear. This is probably not always due to the same direct cause; it may frequently be due to infection of the ground with the fungus *Sclerotinia trifoliorum*.

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* Leaflets No. 160 (*The Cultivation of Lucerne*), and No. 182 (*Crimson Clover*).

Cow grass, or perennial red clover (*Trifolium pratense perenne*), is mainly used for permanent pasture* or leys of extended duration, and differs from the first-named clover in its degree of permanence and in being a single-cut crop. When grown side by side, the difference between the two crops is most striking at harvest time; the aftermath of red clover is then making some headway towards a second or seed crop, while the cow grass is only coming into flower, and, after cutting, produces little or no aftermath or second crop. For this reason the high price of cow grass seed need never occasion surprise.

Description of the Seeds.

There appears to be no real difference between the seeds of red clover and cow grass, so that the description of one seed answers equally well for the other.

The seeds of red clover differ from all other clovers in commerce in form, colour, and size, and it is easy for the analyst or expert to know at a glance that he is dealing with red clover, but when he is required to determine whether a particular sample is or is not of English growth, a great difficulty presents itself, and, under certain conditions, it is almost, if not quite, impossible to determine the origin. If seeds are examined in bulk, however, before they are cleaned, the presence of certain weed seeds may indicate that the sample has had its origin in England, America, or Northern or Southern Europe.

The seeds of red clover (Plate I.) are somewhat oval in shape, and in a general way slightly three-angled, the radicle of the embryo projecting prominently on one side, the colour varying even in high-class samples from light or deepish purple at the broad end shading down to a yellow or greyish-yellow at the narrow end. The evidence of immaturity, and perchance a weakened or deficient germination, is recognized by means of the number of single-seeded seed pods and by the somewhat indefinable shade of yellowish-green which the seeds exhibit. Any sample that contains a goodly number of red or brownish coloured shrivelled-looking seeds should be avoided, as they are either browned by age or by unfavourable weather conditions during harvest.

The farmer, in handling a sample preparatory to purchase, may insensibly, as it were, form a definite opinion in several ways sufficient to give him a direct and practical hold upon the quality and market value of the sample. With care, and a certain amount of experience, he can be fairly certain whether the seed is genuine or otherwise. If the colour is good, fresh and bright, the seeds are likely to be new and of last season's crop. The seeds must also be large and bold,

* *See* Leaflet No. 168 (*Hints on the Formation of Permanent Pastures*).

PLATE I.—WEED SEEDS COMMONLY FOUND IN SAMPLES OF RED CLOVER SEED.

(Each seed drawn to scale and magnified six diameters.)

and fairly uniform in size throughout the bulk, free, or comparatively so, from noxious weeds, and entirely free from the seeds of the parasitic plant Dodder.*

The purity examination of all the seed he sows is of vital importance to the farmer, meaning perhaps to him the difference between a robust, healthy crop, and a weak, straggling, diseased one. If unable to analyse the sample himself, it would be better to expend the necessary small sum required for such an examination by an expert than to risk the possible introduction of weeds and disease into his fields that years of toil may fail to eradicate.

Although the farmer from his own knowledge and experience may be perfectly satisfied from the appearance of the sample of clover he intends to purchase that it is genuine or true to name, and absolutely pure, yet that is not all. If the seeds fail to respond to the germinating test and produce living healthy plants, the purchase is a failure, and the seeds dear at any price.

Weed Seeds found in Samples of Red Clover.

In Plate I., showing the clover seeds and the impurities commonly found in samples of clover, each seed is drawn to scale and magnified six diameters. In genuine American seed a certain number of weed seeds are invariably found, and these, as already indicated, help to determine its origin. The following are shown in the plate :—Rag weed (*Ambrosia artemisefolia*), rib grass (*Plantago major*, var., *Americana*), witch grass (*Panicum capillare*), and, in addition to these, the seeds common to English or European samples, such as ordinary rib grass (*Plantago lanceolata*), spurrey (*Spergula arvensis*), trefoil (*Medicago lupulina*), carrot (*Daucus Carota*), cornflower (*Centaurea Cyanus*), nipplewort (*Lapsana communis*), penny cress (*Thlaspi arvense*), geranium (*Geranium dissectum*), dodder (*Cuscuta trifolii*). Of all the impurities found in red clover, dodder is the one most to be dreaded. Clover seed of any kind containing the seed of dodder should never be purchased, however tempting may be the appearance of the sample or the price at which it is offered.

White Clover (*Trifolium repens*).

White clover is also called Dutch clover, a name given because it was first collected and cultivated as a seed crop in Holland and thence exported to other countries. It is indigenous throughout Europe, but it was not until about the beginning of the eighteenth century that it was sown as a field crop in this country. It differs from red and Alsike clovers, inasmuch as its habit of growth is low and widely

* *See* Leaflet No. 180 (*Dodder*).

creeping, but it is similarly provided with a well-developed tap-root, which enables it to persist and hold its own during a dry scorching summer, while at the same time its prostrate, creeping stems, which give off adventitious rootlets at the nodes, feed mainly, if not entirely, in the upper layers of soil. It may be largely owing to this peculiar rooting habit that white clover can withstand the English climate and is very much less susceptible to climatic changes than red clover. The power of accommodating itself to a great variety of soils and situations may, perhaps, be due to the same cause.

The roots of white clover, in common with other clovers, possess an advantage over other plants in that they have the power under certain conditions—even when grown in soils destitute of nitrogen—of manufacturing albuminoid substances. Hellriegel was the first to discover the true significance of the warts or nodules on the roots of the Leguminosæ, and he ascertained that the nodules contained innumerable nitrogen-fixing bacteria engaged in manufacturing the elementary nitrogen of the air into compounds, which are employed by the host-plant in building up the necessary albuminoid substance.

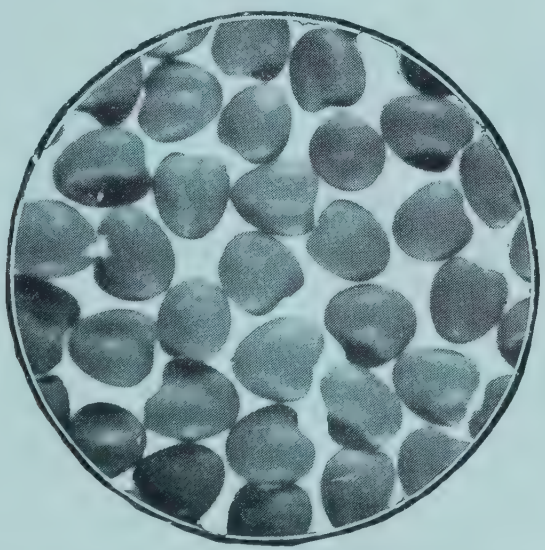


FIG. 1.—WHITE CLOVER (plump, uniform sample, magnified seven diameters).

White clover is found in abundance in all the best pasture land in the country, helping materially, in conjunction with some of the finer grasses, to form a close-bottomed grazing turf of high quality; it is also considered essential and especially valuable on pasture land intended for sheep grazing. In many districts two varieties may be recognized growing in the fields: one, the ordinary white clover of commerce, characterized by its more robust habit of growth, the other a smaller-foliaged variety indigenous to the soil. The seeds of the latter are occasionally offered at Mark Lane

Sorrel

Ox-eye daisy

Goosefoot

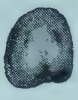
Round leaved Cranesbill

Poppy

Peppergrass

Trifolium repens
White Clover.

White Clover.



Alsike.

Trifolium Hybridum
Alsike

Field pansy

Chickweed.

PLATE II.—SEEDS COMMONLY FOUND IN SAMPLES OF WHITE AND ALSIKE CLOVER SEED.

(Each seed drawn to scale and magnified six diameters.)

as wild white clover, but as there is apparently no difference between the seeds of the two varieties, it cannot be guaranteed true to name.

White clover seed should be used in all seed mixtures for permanent pasture* and in leys of temporary duration; when they are to remain down for more than one year, though the yield is small, it is much more permanent than either red clover or Alsike.

White Clover Seed.

The seeds of white clover are somewhat similar in shape to those of Alsike (*see* Figs. 1 and 3, and Plate II.), though slightly smaller. They are heart-shaped in appearance, and in new fresh seed the bright sulphur or orange-yellow colour is a characteristic feature. Seeds, which are reddish-brown, broken, thin, weevil-eaten, or imperfectly developed, are a fairly common feature of medium or low grade samples.

It is possible, as a rule, to estimate fairly accurately the intrinsic value as well as the commercial worth of a sample by its appearance alone. If the seeds in bulk are uniformly of a fair even size, fresh and of a bright yellow colour, with only an occasional brownish seed, it may be assumed that the seeds are new and at least of average germinating power; on the other hand, seeds which fail to respond to the germinating test have, in all probability, suffered from the weather conditions during the later period of ripening and harvest, or are old or immature. The colour of some of the seeds may have changed from a yellow to a dark red or brown; the greenish-yellow tinge in others is direct evidence of the lack of perfect development.

A good sample of white clover should at the least have a purity of 96 per cent., and the standard of top-price quality should be 98 or 99 per cent.

The progressive farmer should never, under any circumstances, be satisfied by the germinating test alone, for to the uninitiated it is entirely misleading. Though a report as to germinating capacity is comparatively high, the sample as a whole may be of third or fourth rate quality, one-third or one-half the purchase may be rubbish or, what is worse, living weed seeds, as it is the pure and apparently good seeds only that are tested. The combined test of purity as well as germination is the only key or guide to the real cultural worth of any sample.

Weed Seeds found in Samples of White Clover.

Apart from the use of comparatively worthless low quality seed, white clover is rarely or never adulterated, perhaps with

* *See* Leaflet No. 168 (*Hints on the Formation of Permanent Pastures*).

the exception that, when the seed is scarce and prices rule high, an admixture of suckling clover is sometimes used, and, unless the sample is closely scrutinized, it is not readily seen, as the seeds are similar in colour. When examined, however, under a low-power lens, the difference between the seeds is easily recognized, the seed of suckling clover being somewhat cylindrical in shape and very shiny (Fig. 2), while the white clover is heart-shaped (Fig. 1).

Some of the weed seeds (*see* Plate II.) common both to white clover and Alsike are here represented magnified six diameters :—Sheep's sorrel (*Rumex Acetosella*), round-leaved Cranesbill (*Geranium molle*), Ox-eye daisy (*Chrysanthemum Leucanthemum*), Goose-foot (*Chenopodium album*), Poppy (*Papaver Rhœus*), Field pansy (*Viola tricolor*), Chickweed (*Cerastium triviale*), Pepper grass (*Lepidium virginicum*), the last being fairly common in American seeds. Ordinary rib grass, as illustrated in Plate I., is also found in more or less abundance in many samples of white clover and Alsike. The seeds of dodder are rarely found in white clover.

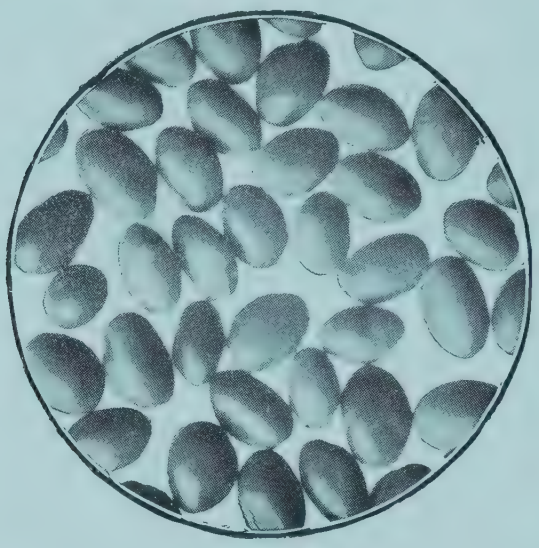


FIG. 2.—SUCKLING CLOVER (sometimes used to adulterate white clover; magnified seven diameters).

Alsike (*Trifolium hybridum*).

Alsike clover derives its common name from the fact that though indigenous to Southern Europe it was first introduced into this country from the village of Alsike, in Sweden, about seventy years ago. The specific name of *hybridum* was given to it by Linnæus, who regarded it as a cross between red and white clover.

The colour of the flower-head—the outer florets of which are tipped with purple or pink—imparts to the plant the appearance of an intermediate form between red and

white, no doubt giving rise to the supposition that it is a cross, but on this point opinions are divided, for, notwithstanding the whitish-pink colour of the flower-head, it is now believed to be a distinct species.

Alsike clover is truly perennial in character and useful for both temporary and permanent pasture.* It attains its maximum yield on moist loams and clays, and is favoured rather than otherwise by wet seasons. Of all clovers it is the only one suitable for irrigation. Owing to its surface-rooting habit the yield on light dry land is correspondingly meagre ; on land suitable to its development it is more permanent than red clover, and superior to white clover by its upstanding leafy growth, which enhances both the quantity and quality of the hay crop. In pasture land the tread of cattle affects its growth but slightly, if at all, and after depasturing, new shoots quickly spring into growth. It stands heat and cold, and on " clover-sick " land, which is unfavourable to a healthy crop, it is indispensable as a substitute for red clover.

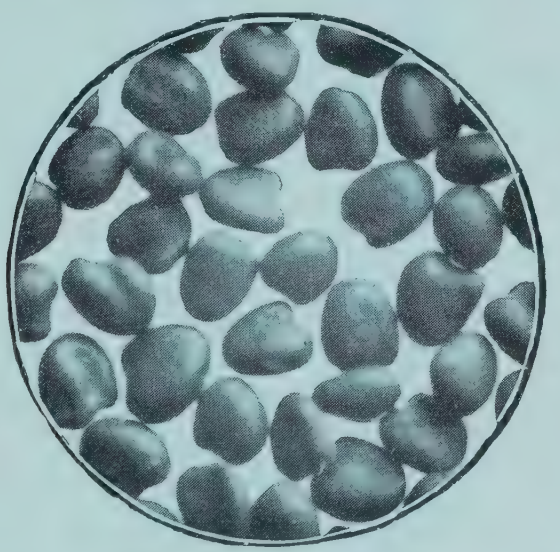


FIG. 3.—ALSIKE CLOVER (good sample ; magnified seven diameters).

Alsike Clover Seed.

The seeds of Alsike, like white clover, are heart-shaped, and in good samples should be plump and uniform. The colour is very variable in different samples, and even in the same sample there may be dark green, yellowish-green, and pale green seeds; alternate shades of light and dark green in many cases give the seeds a somewhat marbled appearance, which is characteristic of many samples. The variations are largely due to the maturity or the ripeness of individual seeds, yellowish-green indicating immaturity, while brown or reddish-brown indicates advancing age or weather influence about or during harvest time.

* *See* Leaflet No. 168 (*Hints on the Formation of Permanent Pastures*).

Weed Seeds found in Samples of Alsike Clover.

The seeds of Alsike (Fig. 3) contain in most instances the impurities common to white clover, perhaps with the striking exception that while dodder is but seldom found in white clover, it is not unusual in Alsike. Samples of Alsike containing dodder very frequently exhibit a peculiar sickly greenish hue, and this leads one to think that the development of the seed has been interfered with by the ravages of the parasite which has robbed the plant of its food. Lightish green, immature samples of Alsike, therefore, should be closely scrutinized for dodder seeds.

Unless the presence of a high percentage of weeds and other rubbish is regarded as adulteration, Alsike cannot be said to be often adulterated. But it sometimes contains a considerable proportion of the seed of timothy, white clover, suckling clover, and trefoil. The purity and germination of good samples should be similar to that of white clover.

4, Whitehall Place, London, S.W.,
January, 1907.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained, free of charge, and post free, on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 185.

BOARD OF AGRICULTURE AND FISHERIES.

Bean Pod Canker.

BEAN PODS, SHOWING CANKER.

The pods of scarlet runners and French beans suffer most in this country from the attacks of this parasite. In America it is said to be parasitic on the living rind of cucumbers, vegetable marrows, water-melons and musk-melons.

On the pods the first indication of the disease is the appearance of small, scattered, dark-coloured specks surrounded by a reddish line. These spots gradually increase in size, and often run into each other, forming irregularly-shaped patches which become sunk below the general level of the surface. In due course the sunken brown patches

become more or less covered with a thin whitish crust, consisting of a dense mass of spores or reproductive bodies of the fungus. When mature these spores are carried by rain, insects, &c., and infect neighbouring plants.

Pods that are attacked when quite young frequently become variously bent and contorted. The parasite often passes quite through the pod and attacks the beans. If such infected beans are used for seed the crop shows the disease at an early stage of growth, and is killed before the flowering season is reached.

Although the appearance of the disease on the pods is accepted as the first evidence of its existence by the gardener, it nevertheless usually appears first on the stem, where it forms brownish sunken patches. If such patches are confined to one side of the stem the plant is not killed outright, and the injury may escape notice; on the other hand, when a diseased patch girdles the stem, the portion above the wound withers and dies. In some instances the leaves are also attacked, and the diseased portions soon become dry and drop out, leaving irregular holes usually attributed to the ravages of insects.

As a rule the pods are infected by spores produced on the stem or leaves, and consequently much depends on dealing with the disease on its first appearance.

Preventive Measures.

Bordeaux mixture of half the normal strength* should be used until the pods are set, after which a solution of potassium sulphide—one ounce dissolved in four gallons of water—should take its place. Even this fungicide should be discontinued when the pods are about half-grown.

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* To make normal strength Bordeaux mixture:—(1) Dissolve 20 lb. of sulphate of copper (bluestone) in a tub of cold water; (2) slake 10 lb. of lime in another vessel; finally, mix the contents of the two vessels in a wooden tub by stirring thoroughly, and make up to 100 gallons. To make this half the normal strength double the quantity of water must be used.

4, Whitehall Place, London, S.W.,
November, 1906.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Large Larch Sawfly.

(*Nematus Erichsoni*).

The importance of a careful outlook by the sylviculturist and the arboriculturist in order to observe whether there seems to be any increase above the normal of a special insect, receives once more strong support in the recent ravages of larch, by the caterpillars of the large larch sawfly over a large area in Cumberland. There are in Great Britain native species of forest insects which once and again on the Continent or elsewhere have been the cause of immense loss, and yet in Britain have never attracted attention by any serious damage, or, indeed, by any damage at all. There is always, however, the possibility of trees being damaged by such species, and the danger will grow with the increased area that may be put under forest crops, and with the massing together of great numbers of the trees of one species.

Nematus Erichsoni is not a very common insect in Britain or in Europe generally. It is not even mentioned by name in the literature of wood or forest injury in Britain, and it is almost passed over in the Continental forest literature as of little forest importance. The increase, however, of this insect in the last three years over a considerable area in Cumberland, and the damage there done by its larvæ, is a matter of great importance, and may, unless careful outlook be kept, have grave results elsewhere. It were a pity, after the loss and discouragement caused by the larch canker fungus,* if a second scourge in the shape of this sawfly enemy should follow. British foresters should be on the alert against this possibility.

Previous History of Nematus Erichsoni.

In the forest literature of the Continent there are references to the larvæ of the large larch sawfly as having been the cause of damage to larch in the Harz Mountains,

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* See Leaflet No. 155 (*Larch Canker*).

in Holland and in Denmark. The references are chiefly antecedent to 1840; the most recent is from Denmark, in 1902. The insect has been recorded in Western Europe, from Sweden in the north to as far south as France.

As regards Britain, Cameron* writes: "*Nematus Erichsoni* does not appear to be a common species."

In the United States of America this sawfly has been catalogued as one of the most destructive forest insects, the larvæ, in the North-Eastern States, having at different times defoliated the larch.

Defoliation of Larch in England.

During the summer of 1906 the caterpillars of *N. Erichsoni* were at work in very large numbers over a considerable area in Cumberland. The trees cover the mountain up to an elevation of 1,600 feet. Part of the area is made up of pure larch, which suffered more than another portion of the wood where the larch is mixed with oak and a few other broad-leaved species. The attack was first observed in 1904; it was more serious with the spread of the insect in 1905; and again in the summer of 1906 great damage was done. Caterpillars were sent to the Board of Agriculture and Fisheries for determination and report in August of 1906, and a visit to the affected district followed.

The area worst infested was a wood somewhat conical in shape, and hence exposed to all points of the compass, the largest part, however, facing south. The age of the trees attacked varied from twenty years to seventy years and over, and the fact of tall trees being attacked adds greatly to the difficulty of satisfactorily combating the caterpillars and the adult sawflies. When the area was inspected in the last week of August, the brown and withered appearance of many of the trees attested the severity of the infestation. At some hundreds of yards distance, looking up at the wood, the eye could easily pick out the defoliated trees. Some of them were practically in their winter condition, devoid of leaves. Others which had been defoliated in July had by mid-August started to produce new leaves, so that on inspection at the end of August such larches appeared as they normally do in April or May, with the dwarf shoots bearing tufts or clusters of partly grown leaves (Fig. 8).

Some seventy-year old larches felled at the end of July and the beginning of August were infested with thousands of the sawfly caterpillars. These caterpillars, many of them dislodged by the fall of the trees, made their way to the trees standing near and attempted to ascend them, the bases of the trunks of several hawthorns, for example, being hidden by

* "A Monograph of the British Phylophagous Hymenoptera," Vol. II., p. 57, 1885.

THE LARGE LARCH SAWFLY (*Nematus Erichsoni*).

(For description of figures, *see* p. 7).

their numbers. The caterpillars, numerous and easy to find on the trees up to the third week of August, were by the fourth week, in the great majority of cases, full fed, and had left the trees and made their way into the moss and litter on the ground below, in order to make their cocoons.

Altogether in the neighbourhood referred to an area of over 300 acres was attacked. Examination of other larch woods near by, and of isolated larches here and there at a greater distance, showed that there were still uninfested places, although there was great danger of infection.

Position of Nematus Erichsoni in the Insect World.

The large larch sawfly belongs to the Order Hymenoptera and to the family *Tenthredinidæ*, or sawflies. The sawflies are so called from the fact that the ovipositor of the female is modified, typically, to form a sawing apparatus, by which openings are made in leaf or twig for the reception of the eggs. The two saws are side by side on the under surface at the hind end of the sawfly. The adult sawflies do not attract much notice, but if examined it will be seen that they do not have the narrow waist characteristic of the wasps but that the base of the abdomen is broadly joined to the thorax. The adults, in nearly every case, are harmless, save that, of course, they lay the eggs. The larvæ are very characteristic: they are caterpillars, which, with one or two exceptions, have more than sixteen legs. In the great majority of cases they feed exposed; a few, however, live in galls, or mine or burrow in plant tissue. Dr. Sharp reckons that nearly 400 species have been found in Britain, and amongst these are species troublesome in gardens, and to fruit, and in agriculture. Six or seven genera contain species of importance in forestry, of which *Lophyrus* (see Leaflet 103), *Lyda*, and *Nematus* are the most important.

The species of the genus *Nematus* that have relation to forestry affect, amongst broad-leaved species, the willow chiefly. The interesting, and sometimes injurious, caterpillars of *Nematus septentrionalis*, besides feeding on willow, attack also the leaves of birch, hazel, alder, and mountain ash. On the larch, besides *Nematus Erichsoni*, the large larch sawfly, *Nematus laricis*, the small larch sawfly, also occurs.

Description of Nematus Erichsoni.

Adult.—The adult sawfly (Figs. 1 and 1*a*) measures up to $\frac{3}{4}$ inch, or a little over, in length, and in spread of wings just less than an inch. The ground colour is black. The head and thorax are black; the first joint of the abdomen is black; then follow joints coloured red; the end of the abdomen again being black. The mouth parts, the two front pairs of legs,

except at the part next to the thorax, and the upper parts of the femora of the hind legs, are reddish or reddish-yellow. The tibiæ are yellowish or pale in the upper parts. The antennæ are nine-jointed and somewhat thick, and taper towards the apex. With a lens the head and thorax are seen to be sparsely and finely pubescent, and the thorax is markedly punctured. The wings are glassy aud slightly clouded below the stigma.

Egg.—The egg is longish oval, and measures just over a millimetre in length. It is white in colour.

Larva.—The full-grown caterpillar (Fig. 2) measures three-quarters of an inch, or a little over, in length. It has a round black hairy head, with a single ocellus (simple eye) on each side. On the upper surface, all down the back, the colour is grey-green; the sides are lighter; the under surface is yellowish-green. If a lens is used transverse rows of minute warts with spines will be seen on the abdominal segments. The spiracles along each side are brown. The legs number twenty, viz., three pairs of thoracic legs, which are black, and seven pairs of abdominal legs, which have the colour of the underside of the body. The head is followed by twelve segments or joints—1, 2 and 3 are thoracic joints, and each bears a pair of legs; 4 to 12 inclusive, are abdominal joints; 4 has no legs; 5, 6, 7, 8, 9 and 10 have each a pair of legs; 11 has no legs; and 12, the last joint, carries a pair of legs.

Packard* describes the caterpillar as moulting three times, and so distinguishes four stages of larva. On hatching, the head is very large and dusky green, not black; neither are the thoracic legs black; the body is uniformly pale green. After the first moult the head and thoracic legs are black; the body is wrinkled, but no warts show. After the second moult the upper surface is grey-green, and the transverse rows of warts appear. The caterpillar attains its full size after the third moult. The moulted skins can be seen wound round, or attached to, the leaves (Fig. 7).

Excrement.—The castings (excrement) of the caterpillar are longish, cylindrical, and somewhat square cut at the ends (Fig. 3). The castings observed on the ground will afford a hint as to the presence of the larvæ. So numerous were the caterpillars in some parts of the attacked area in Cumberland that in July their excrement falling on leaves below suggested the patter of rain drops.

Cocoon.—The cocoon (Fig. 4), strong and leathery, or parchment-like, is dark brown in colour; it is cylindrical in shape, with rounded ends; the inside is smooth, the outside shows a raised network pattern. The size may be taken on the average as between $\frac{3}{8}$ inch and $\frac{1}{2}$ inch.

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* Fifth Report of the United States Entomological Commission; "Forest Insects," 1890.

The following tables may assist in making certain the determination of the large larch sawfly.

Moth Caterpillars.	Sawfly Caterpillars.
Head somewhat hollowed out, not markedly globular.	Head globular.
A group of ocelli on each side of the head.	One ocellus on each side of the head.
Hooklets on the abdominal legs.	No hooklets on the abdominal legs.
Legs 16 in number or less.	Legs more than 16.
The Geometer moth caterpillars, of which at least three species feed on larch, have a less number of legs than 16. The caterpillars of the larch mining moth (this was quite common in Cumberland, and is often a serious enemy of the larch) mine into the needles, causing the upper half to shrivel up; these caterpillars are very minute, and make cases for themselves in hollowed out parts of the needles.	Genus *Lophyrus*. *e.g.*, the pine sawflies, not found on larch. The caterpillars have 22 legs.
	Genus *Nematus*. The caterpillars have 20 legs,

The Large Larch Sawfly. *Nematus Erichsoni.*	The Small Larch Sawfly. *Nematus laricis.*
Adult 10 mm. in length, and with red on the abdomen.	Adult 6 mm. in length and quite black.
Thorax prominently and thickly punctured.	Thorax not prominently punctured, and may be quite smooth.
The eggs are laid on the young shoots.	The eggs are laid on the buds.
Caterpillar measures up to 22 mm. and is grey-green on the back, lighter on the sides.	Caterpillar measures up to 15 mm., and is grass-green or greenish-brown.
Head of caterpillar black.	Head of caterpillar brown.
Caterpillars feed till the end of August.	Caterpillars full grown in July.
The caterpillar eats especially the leaf clusters or tufts.	The caterpillar eats more commonly the single leaves on the shoot of the current year.

Life History and Habits of the Large Larch Sawfly.

The caterpillars winter under cover of the cocoons, and pupate, generally speaking, in May or June, according to the conditions. The adults probably issue in June. The eggs are laid, in one or two rows, on the youngest larch shoots, and in slits in the bark made by the saws of the females. Packard saw the eggs laid at the bases of the young leaves. (It will be recalled that on the new shoot or shoot of the current year in the larch the leaves are not in clusters but are arranged singly.) The presence of the eggs may cause the shoots to curl somewhat, and on occasion the leaf at whose base an egg had been laid, dies. As the embryo develops the slit in the shoot gapes a little, and through the oval hole the caterpillar creeps on hatching. The caterpillars may begin by gnawing the single leaves on the young shoot, but they soon pass to the clusters of needles on the dwarf shoots. Single leaves may be eaten so that the edges appear

serrated, or the clusters of leaves may be half eaten or quite destroyed so that only stumps are left (Figs. 5 and 6).

In the young condition the caterpillars may be found in clusters. They assume various positions, arranged with the tail end curled round the shoot; or like a mark of interrogation, or the letter S; or (a characteristic attitude) with the hind half of the body turned upwards and over the front half (Fig. 7). On being handled the caterpillars wriggle violently, rolling themselves about in a fashion similar to surface caterpillars, ultimately lying on their side with their body forming a circle, the tail end touching the head.

The larvæ are to be found at work during the summer, and most numerously in July and the first fortnight of August. By the end of August most have left the trees. Some, however, do not complete their growth till September. The full fed caterpillars leave the trees and pass into the moss or litter or the soil below, and in such shelter places spin the cocoon in which they pass the winter. They lie somewhat bent in the cocoon until the late spring or summer of the next year, when they turn to pupæ, the adults issuing in due course.

There is no evidence so far that there are two generations in the year, and yet the caterpillars seem to attain full size in a comparatively short time.

Age of Trees Attacked.

Infestation in the larches in Cumberland was upon trees of from twenty to seventy years of age. The records elsewhere show that young plants of ten years of age may be attacked, but attack has been reported more frequently on older and taller trees. The fact that the caterpillars work on well-grown trees, and it seems characteristically at the crown first, greatly increases the difficulty of fighting them.

Preventive and Remedial Measures.

1.—Against the adults scarcely anything can be done effectively. They lay high up, well out of reach, so that the placing here and there of tarred boards standing erect and with the tar frequently replenished, which is practised sometimes against sawflies that lay on young plants, cannot be tried with hope of success.

2.—If young trees chance to be affected with the caterpillars, these especially when small and, it may be, in clusters, should be squeezed in a gloved hand or rubbed off the shoots into a small hamper; or badly infested shoots could be snipped off or cut through and dropped into the hamper. The contents of the hamper should then be emptied on a slow-burning fire. This measure, practised against the pine sawfly, will often be impracticable against the caterpillars of the large larch sawfly, feeding as these do, out of reach.

3.—Jarring the trees to shake down larvæ would meet with most success on a dull day or early in the morning when the caterpillars are cold and sluggish.

4.—Where the caterpillars are out of reach and the trees attacked are isolated, or where the infestation is limited, the trees should be sprayed with (*a*) fresh white hellebore, 2½ lb. being mixed with 10 gallons of water, the mixture to be kept agitated while spraying ; or (*b*) Paris Green in the form of paste, 1 lb. to 150 gallons of water ; or (*c*) lead arsenate, made by dissolving 1 oz. of arsenate of soda in a little water, then dissolving 3 oz. acetate of lead in a little water, finally mixing the two solutions. This mixture should then be made up to 10 gallons by the addition of water.

5.—When infested trees are felled the dislodged caterpillars should be destroyed.

6.—A certain amount of help is rendered by Nature. Birds may take the caterpillars : in the Cumberland wood referred to rooks and jackdaws were seen to be feeding on the caterpillars during July. Parasitic ichneumon flies are active enemies of the caterpillars.

7.—The cocoon stage comes within reach of practicable treatment if the infested area be not too wide. The litter and surface soil below attacked trees could be ploughed in deeply so as to bury the cocoons, or in a prescribed area boys could be employed to collect them, or the soil and litter and moss could be collected together in little heaps. If quicklime were placed on these heaps and water sprinkled over them the heat engendered would kill the enclosed caterpillars. Swine, useful in some insect infestations against pupæ in the soil, are not here of value as they refuse to eat the cocoons.

A fuller account of *Nematus Erichsoni*, with a coloured plate, was published in the *Journal of the Board of Agriculture* for October, 1906.

Description of Figures :—Fig. 1, *Nematus Erichsoni* (magnified) ; Fig. 1*a*, *Nematus Erichsoni* (natural size) ; Fig. 2, Larva ; Fig. 3, Excrement of larva ; Fig. 4. Two cocoons, each magnified 1½ times ; Fig. 5. Some injured leaves magnified ; Fig. 6, Larch twig defoliated by the larvæ ; Fig. 7, Larvæ on twig of larch : on one of the needles a moulted skin is seen ; Fig. 8, Larch twig, drawn in September, that had been defoliated and was then putting out new leaves. Figs. 1 and 1*a* are after Packard, all the others are drawn from nature.

4, Whitehall Place, London, S.W.,
February, 1907.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 187.

BOARD OF AGRICULTURE AND FISHERIES.

The Selection and Milking of Dairy Cattle.

The importance of obtaining really first-class dairy stock has for a long time been recognised by practical men, and the degree of perfection which has been attained in the production of excellent types is well seen in the results obtained by the best breeders of the Channel Islands and Ayrshire cattle. In the production of cattle for dairy purposes one of the chief objects to be kept in view is the purpose for which the milk is being produced.

1. When milk-selling is the object, the farmer will strive to obtain a large volume of milk, the quality of which will exceed the limit prescribed by the Sale of Milk Regulations.

2. Should the object be butter production, the quantity of milk produced is not of so much importance as its richness in fat, for it is this constituent of the milk alone which can be utilised in this connection.

3. The aim of the cheese-maker is to obtain plenty of milk which is of good quality, for in the production of uniformly high class cheese, quality in the milk is imperative. If manufactured into butter at times of the year when cheese-making is not carried on, such milk will yield a satisfactory amount of butter.

Suitable Breeds.

Examples of breeds which are suitable for special purposes are mentioned on p. 2. There are many milk sellers whose object is to find a cow of either a pure or cross-bred type that will give milk ample in quantity and good in quality. In purchasing cross-bred animals, care should be taken to ascertain the ancestry both on the part of the sire and of the dam. The animal that will yield eight hundred to a thousand or more gallons of milk a year is a most valuable asset; especially is this the case if the milk is of a quality well above the limit prescribed by the Sale of Milk Regulations, for at times, when it is realizing a low price, it may be kept at home and manufactured into either butter or cheese. While cows that will yield the quantity of milk specified may be bred or bought, in all probability the average quantity of milk yielded per cow throughout the country would amount to little more than 400 gallons. This quantity is much lower than it should be. Cows yielding large quantities of milk cost little, if any more, for keep and labour than those yielding small quantities, while the returns

obtained are sufficient to make the difference between a substantial profit and a heavy loss. Another point to be taken into consideration in selecting an animal for the dairy is that a cow, after her milking days are finished, should be able to put on flesh and be saleable as beef. Dual-purpose cattle, or those that will milk well and afterwards produce good beef, and that produce calves of a type that make good feeding beasts, are doubtless a type much to be desired; but there is a difficulty in finding any breed which combines in the highest degree the best milking and feeding qualities. Shorthorns, Red Polls and South Devons, as well as the little Dexters are, however, of considerable value from this point of view. Probably the carefully-bred Dairy Shorthorn is the nearest approach to an ideal dual-purpose cow. Before discussing the special characteristics of the dairy cow, and the points which will help in the selection of general purpose cattle, the suitability of the leading dairy breeds for certain districts and purposes may be pointed out :—

Suitable for Good Land.	Suitable for Exposed Country.	Specially Adapted for Milk-selling.	Most Suitable for Butter-making.
Dairy Shorthorns.	Welsh.	Dairy Shorthorns.	Jerseys.
Lincoln Reds.	Ayrshires.	South Devons.	Guernseys.
South Devons.	Kerries.	Lincoln Reds.	South Devons.
Jerseys.	Dexters.	Welsh.	
Guernseys.		Ayrshires.	
Red Polls.		Red Polls.	
		Kerries.	

For cheese-making localities, Shorthorns, Ayrshires, Devons, and Welsh are most in demand. Where the morning milk has a tendency to contain a low percentage of butter-fat, as is sometimes the case with the heavy milking breeds, an addition of about 10 per cent. of milk from Channel Islands cows will help to raise the general quality of the milk and to maintain the required amount of fat.

Points of Dairy Cattle.

The special points to be considered in the purchase and judging of dairy cattle are :—(1) General appearance denoting constitution and milking qualities, and that conformity to type which is noticeable in all well-bred animals; (2) Shape and capacity of the udder, and size of milk veins and teats; (3) Indications as to quality and quantity of milk yielded.

1. *General Appearance.*—The ideal dairy cow, no matter of what breed, should be wedge-shaped when looked at either from the side or from behind, both top lines and side lines tapering from the hind quarters toward the neck. The

head should be fine, and the eyes prominent; the neck and throat clean; the horns small and not coarse. The dewlap if any should be thin and not fleshy. The shoulders should be light and oblique, with rather pronounced withers free from flesh, while the back should be lean and show strong spinal processes. The hips should be placed wide apart; the rump long and wide, with a fine tail well set on, reaching down to the hocks, and carrying a good switch. As regards the thighs these should be long and lean, and the flanks thin; with hocks wide apart and set square, plenty of room will be allowed for the udder. The abdomen should be capacious. In comparison with a "beef" animal a pure dairy cow will appear flat-sided, but "depth" of body which denotes constitution will make up for this apparent defect.

If the cow is one of the Channel Islands breeds, the hoof should be small, and bright in colour, the skin "mellow," soft, and "creamy," and the horns "crumpled", clean and bright, well set on, yellow at the base and black towards the tip.

2. *Shape of Udder, &c.*—The udder or bag should extend well forward,—the fore teats in some cows will be found in a vertical line with the hip bone. The udder should be full and capacious but not fleshy, soft to the touch, flat underneath and well rounded behind, each quarter being sound and the teats easy to draw. The teats should be evenly placed, squarely set on, and of a useful size for milking.

The milk veins should be large, prominent, and branched.

3. *Points indicating Quality and Quantity of Milk.*—"Touch," which is best judged by taking hold of a portion of the skin and flesh behind the last rib, should be "mellow," the skin loose and rather thin, and of a slightly oily nature, and the hair soft and velvety. Ears which are fine, well fringed with hair, and of a deep yellow colour inside, are usually regarded as certain indications of good quality and colour of milk and of butter. Horns should be yellow at the base and show no coarseness, and the shape of the head should incline rather to the Jersey than to the Ayrshire type. Points indicating quality and colour of milk are much more apparent in Channel Islands cattle than in other breeds. As regards constitution, a deep chest gives plenty of room for lung development, whilst wide and open nostrils commonly show good lung capacity. The ribs immediately behind the shoulder, if round and deep, make a big heart girth, whilst ribs wide apart give the cow the appearance of strength and solidity. Generally speaking, a good cow possesses a loosely-knit frame.

The size, shape and feel of the udder, and the general appearance of the cow are perhaps the best indications as to the quantity of milk likely to be yielded.

Cows which are heavy milkers are frequently thin and bony, but the buyer should not refuse a cow solely because of her "poor" appearance, cases being known in which such animals have yielded upwards of 1,000 gallons of milk per annum.

Milking.

Of late years much has been said and written on the subject of a pure milk supply, the chief responsibility for which rests with the owners of cows. It is the duty of those engaged in the production and sale of milk to see that all cows are in good health, and fed in such a manner as to produce sound milk. It is essential that the milk from any cow which is not in perfect health should not be mixed with the general supply of the herd, and this point merits the careful attention of the owner or his foreman. The milk from any cow continually ailing should not even be given to pigs or poultry unless previously boiled, as there is always danger of the transmission of disease. In every herd of cows there are animals which will suffer from ailments of a temporary character. Such cases should be given immediate attention, and their milk for the time should not be used with the rest.

Cleanliness.

Cleanliness is one of the most important items in connection with all dairy work, and no amount of skill in the dairy will counteract ill-treatment of cows and lack of cleanliness in milking, &c. Every cow should be kept well groomed, and the udder and off flank especially carefully rubbed over with a sponge or rough damp cloth before milking is commenced. Milkers should wear clean garments and wash their hands with soap and hot water prior to commencing operations and again after each cow is milked. Milking into pails loosely covered with muslin or straining cloth is strongly to be recommended.

Cows frequently get very dirty in the byres owing to the bad construction of the standings. These are commonly too long, and the mangers are placed too high, so that when the cows lie down, they have to draw back and lie in their manure. The cure for this is to place the mangers on the ground and shorten the standings to the length of the cows, putting a gutter of moderate depth behind them. The animals will then lie down with their heads over the mangers, and the manure will drop into the gutter. The expense of making these alterations is not necessarily great, and the saving of labour in the lessened cleaning the cows require, to say nothing of the improved condition of the milk, will soon repay the

outlay on these very necessary alterations. The grooming of the cows will be reduced to a minimum, and the udder and flank will not have to be washed so frequently, since these parts should be nearly as clean as the rest of the animal.

Clean Milking.

The use of any organ of the animal body undoubtedly promotes its development, and this particularly applies to the udder, for the process of milking, if carried out thoroughly, increases the milking capacity. To secure the greatest development of the udder, it is necessary that the milking should be carried out very completely, and no milk should be left behind at the end of each operation. There are two reasons for withdrawing all the milk that can be obtained from the udder: firstly, to develop and increase the milking powers; secondly, to obtain the richest portions yielded during the whole of the milking, namely, the "strippings" as they are termed, which contain from 8 to 10 per cent. of fat, while milk of average quality contains only 3·7 per cent. of fat. Failure to withdraw all the milk from the udder at the time of milking is the commonest cause of cows drying off soon, for a prolonged lactation period can only be obtained where the complete removal of milk at each milking is effected.

The common method of milking—that of grasping the teat with the full hand and exerting a slight downward pull at the time the hand is closed—is not effective in stripping the cow. Stripping is carried out by the method known as streak milking, in which the teat is taken between the thumb and fore-finger, or fore-finger and middle finger, then tightly pressed and drawn downwards. This method of milking is suitable for the purpose of stripping, as by its adoption practically all the milk from the udder may be withdrawn. It is not, however, advisable for ordinary milking, on account of its being likely to irritate the teat externally, and even in some cases to cause inflammation.

It is a question as to which teats should be milked together. A good delivery of the milk to the pail may be got by grasping a near fore and an off hind teat, and then reversing the order. In the majority of cows, however, the hind teats yield the most milk, and, if one hand is being used to milk a fore and the other a hind teat, the operation is not usually completed simultaneously. By taking, say, the two fore teats, and then the two hind teats, a more equal flow of milk is obtained, and this is, on the whole, the best method of milking. "Stripping" should end with the fore pair of teats.

Hard Milkers.

Cases are sometimes met with in which cows are very difficult to milk, being termed "hard milkers." Cows are frequently so at their first calving, but usually improve with milking or suckling a calf. Occasionally cows may have become difficult to milk owing to the milker having for a lengthened period adopted a severe method of milking such as the streak method before mentioned, the result being that persons accustomed to the more gentle procedure would find difficulty in milking such animals.

Wet or Dry Milking.

Milking may be performed with either wet or dry hands. In the former case the hands are commonly moistened by drawing on to them a few streams of milk, but this is hardly a cleanly habit. If the hands are washed before milking each cow they should be sufficiently damp, and the moistening mentioned above will not be necessary.

Many competent persons advocate each method, but taking all points into consideration, the dry method is the more cleanly of the two, and is that adopted by the best dairymen. As stated in Leaflet No. 151 (*Cleanliness in the Dairy*), milking with wet hands is an objectionable practice ; and in cases where the teats have become tender the use of vaseline is recommended.

Essentials of Good Milking.

The essentials of good milking are that it should be performed, (1) Quietly : that is to say, the milk should be withdrawn in a manner that will cause no discomfort to the cow ; (2) Quickly : if performed quickly more milk is obtained, for rapid milking appears to be beneficial in increasing the flow. A comparison of the results obtained by good and inferior milkers makes this point very clear. A good milker is able to milk from seven to ten cows in an hour, the common indication of good milking being the production of plenty of froth or "head" upon the milk in the pail. (3) Thoroughly : the last milk, being the richest, must always be withdrawn.

In the milkers' contest held at the London Dairy Show, in which no competitor is allowed to milk his own or his employer's cows, the following are the points upon which competitors are judged :—(1) Manner of approaching the animal, and style of work, 20 points ; (2) Cleanliness, 10 points ; (3) Clean stripping, 10 points ; Total, 40 points.

Many cows seem to enjoy the milking process, and whilst all get accustomed to it and expect it to be carried out at certain fixed times, much depends upon the milker as to whether the cows look forward to the milking time or not. Roughness on the part of the milker should not be tolerated. Women are on the whole better milkers than men.

Times of Milking.

The common practice is to milk twice in twenty-four hours, and the more equally the time is divided the more uniform will be the quality of the milk produced. For example, if milking takes place at six o'clock in the morning, the next milking time should be as near six in the afternoon as possible. This is easily recommended, but it must be admitted that it is often difficult to carry out in practice, especially in the case of those farmers who supply warm milk for consumption in towns. The demand in towns is for milk to be delivered before breakfast, and again in time for tea, and this usually means starting milking at 6 o'clock in the morning, and again at 2 p.m. This results in intervals of sixteen hours and eight hours respectively, and as a consequence it frequently happens that the milk yielded at the morning milking is inferior in quality. Perhaps on most farms, however, where milk is sent away by train, milking could conveniently commence between 5 and 6 in the morning and between 4 and 5 in the afternoon, thus giving approximate intervals of 11 hours and 13 hours between milking.

Cows like to be fed and milked at regular times. If milking is delayed they frequently become uneasy, and the irregularity may cause considerable depreciation in the amount of milk obtained. Cows which are left too long without milking get very distended udders, and may suffer considerable pain. Very heavy milkers have sometimes to be milked three times instead of twice a day, to relieve the pressure on the udder. Over-stocking, or allowing the udder to become unduly distended with milk by failing to milk a cow previously to exposing her for sale at a market or sale, is not only a common but a cruel and dangerous practice. It may lead to inflammation of the udder, and often results in the loss of one or more quarters, while it may prove fatal to the cow.

General.

Kicking during Milking.—Owing to heifers being badly trained or ill-treated they may develop the habit of kicking during milking time. When they first calve heifers are often very sensitive when being milked, and unless they are kindly treated, may subsequently prove a great nuisance to the dairy farmer. Kind treatment in the early days is likely to prevent kicking, but some cows can only be milked when some appliance is used to prevent them from kicking. Two means commonly employed are strapping the legs together with a heavy strap, or strapping one leg to the stall, but neither should be employed unless absolutely necessary.

Drying Off.—Some cows are so prone to milk that they will continue in milk from the birth of one calf until the

next is due. Though the continuous production of milk is valuable to the dairyman, the cow, unless allowed some period of rest between each calf, suffers very considerably from the strain : poorer calves are likely to be produced, while the milking powers may be impaired. Whilst the majority of cows do not milk for more than nine months at a time, many good dairy cows only dry off for a month or so previous to calving. It is desirable that a resting period of six or eight weeks should be allowed to each cow before calving. The quantity of milk can be reduced by milking less frequently, finally milking once every other day, then every third day, or even less frequently than this, depending upon the condition of the udder, until so little milk is secreted that it is unnecessary to withdraw it.

Importance of Milk Records and Milk Testing.—It is desirable that those who are anxious to improve their dairy stock should weigh the milk of each cow morning and evening, and note the yield in a book specially kept for the purpose. Or, if this cannot be done, each cow's milk should be weighed morning and evening one day a week and multiplied by seven at the end of the milking period. This would give the approximate total. The daily record, however, is to be recommended. In conjunction with the record of the weight of milk yielded by each cow, at least an occasional test for the amount of butter-fat present should be made.* The value of such records, which show both the quantity and quality of milk of individual cows yielded during their lactation period, cannot be over estimated. The value of the increased milk yield of the herd year after year, consequent on the judicious weeding out of inferior animals, well repays the small additional expense of the work entailed in making such records.

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* *See* Leaflet No. 146 (*Tests for Farmers' Milk*).

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BOARD OF AGRICULTURE AND FISHERIES.

Fumigation with Hydrocyanic Acid Gas.

During the past few years the method of destroying various insect pests by means of fumigating with hydrocyanic acid gas has been much advocated, and the recommendation has been made in certain of the Board's leaflets. For the destruction of mussel scale, woolly aphis, mealy bug, thrips, weevils, and red spider in greenhouses, &c., the method is very valuable, while it may also be employed for the fumigation of poultry houses in case of infestation by lice and mites.

Nursery stock fumigated with hydrocyanic acid gas before planting will be freed from insect enemies in all stages save that of the egg.

Materials to be used.

The materials necessary for purposes of fumigation are :—(1) potassium cyanide of 98 per cent. purity ; (2) sulphuric acid of a specific gravity of not less than 1·83 ; (3) water ; (4) jars and a glass measure.

The following quantities may be taken as a standard for use :—Potassium cyanide 1 part, sulphuric acid $1\frac{1}{2}$ parts, and water $3\frac{3}{4}$ parts (all parts by weight).

The proportions of cyanide, sulphuric acid, and water to be used, and the amount of space per unit of cyanide, vary slightly as recommended by different authorities, three different workers recommending 1 oz. of cyanide of 98 per cent. purity to every 200, or 300, or 500 cubic feet of space respectively.

The variation in the amount of cyanide depends to some extent on the character of the plants that are being treated, on their strength, whether they are dormant or active, evergreen or deciduous, and also on the season. In the case of tender plants, 1 oz. of cyanide may serve for 500 cubic feet of space, while hardy plants may be treated with 1 oz. of cyanide to 200 cubic feet of space.

Treatment of Greenhouses, Conservatories, Nursery Stock, &c.

Method of Application.—The glass-house or other place which is to be treated must be rendered as airtight as possible.

The sulphuric acid should be poured very carefully and slowly into the water, which may be put in an earthenware vessel, *e.g.* a large jam-jar. The cyanide of potassium, wrapped in thin blotting paper, should then be dropped into the now diluted sulphuric acid. The vessel into which the cyanide is

dropped must be so near the door that it can be reached by the outstretched arm of the operator, who should *immediately* shut the door and close up its chinks by paper previously prepared. Another, and better, method is for the operator to introduce the cyanide to the diluted sulphuric acid through a window, the cyanide being placed at the end of a long stick or rod, or being lowered into the acid by a string and pulley. The window must be closed immediately after the addition of the cyanide, so that the operator may escape the fumes. Strawson recommends the pouring of the diluted acid from a bottle fitted with a cork in which two slits are cut, one to let in air and the other to allow a small and even stream to flow upon the cyanide, the object being to provide a slow and even disengagement of gas. The bottle should be arranged so that it can be tilted up when all is ready.

It is of importance also that the hydrocyanic acid gas fumes be distributed over the house, and this may be done by an arrangement of fans which can be worked from the outside.

Fumigation should take place in the evening, or after nightfall, and not in strong sunlight. The temperature of the house should be from 50 degs. F. to 60 degs. F. The plants to be treated should be dry. The surface of the soil of the house should also be as dry as practicable. Experiment has shown that the eggs of the Woolly Aphis* may remain unaffected, and therefore fumigation should be repeated in ten days. Eggs of the Apple Mussel Scale† are also unaffected by gas of the strength mentioned.

Points to be Carefully Noted.—The work should be done by a careful and skilled operator, for the cyanide and its fumes are very poisonous and dangerous to human and animal life.

The treated room or conservatory must be kept closed during fumigation from three-quarters of an hour to an hour, after which the room should be ventilated, the windows, &c., being opened from the *outside*, and no one should enter until an hour has elapsed. While opening the windows, &c., the operator should be careful not to inhale the escaping fumes.

It is safer not to fumigate when the plants are in bloom.

Nursery Stock.—In the treatment of nursery stock the bushes or young trees should be placed in an airtight box or canvas tent of known capacity and subjected to the fumes of hydrocyanic acid gas for one hour. Large numbers can be treated at once at little expense.

When the time has expired the tent or box should be opened in such a way that the wind blows the fumes away from the operator, and should be left to ventilate for half an hour before the stock is removed.

Trees in the orchard may also be treated by the use of a canvas tent or cover.

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* *See* Leaflet No. 34. † *See* Leaflet No. 107.

Canvas Covers for Fumigating.

The practice of using canvas covers for fumigating is not so common in Great Britain as in some other countries, and the method followed in the Colonies may here be given for the guidance of those who wish to undertake orchard fumigation with hydrocyanic acid gas. According to Claude Fuller, the Natal Government Entomologist,* the covers should be of a light, durable material, and comparatively gas-tight, the most suitable probably being canvas. Eight-ounce American duck canvas is recommended.

There are three types of covers: sheets, tents, and box covers. The *sheets* are octagonal in form, and can be further enlarged by sewing on a "skirt" round the edge. These can be easily lifted over small trees up to six or seven feet in height, above which a hoisting apparatus must be used. *Tent covers* may be used for trees up to 13 feet in height. They take the form of dome-shaped tents, the mouth of which is kept open by a ring of gas-piping passed through canvas loops, and they can be quickly lifted over and removed from 8 to 13-ft. trees by a couple of men, where the hoisting of a sheet would take three or four. *Box covers* are made to any convenient size by covering a wooden framework with canvas or calico; the latter material should be painted or oiled to make it sufficiently gas-tight. They are especially adapted for small trees and bushes.

Note.—As both the potassium cyanide and the hydrocyanic acid gas are deadly poisons, the former should be kept in a tightly stoppered bottle and labelled *Poison*, whilst the gas as generated must on no account be breathed. Fumigation should not be carried out in a high wind, nor when the trees are wet, but otherwise it may be done at any season of the year.

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* "Natal Agricultural Journal," July 28th, 1905, p. 697.

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BOARD OF AGRICULTURE AND FISHERIES.

Insurance of Farming Stock against Fire.

Among the various risks to which the crops, produce, and live stock of the farm are exposed, that of destruction by fire is not the least, but it is fortunately one of the few risks against which farmers are able to protect themselves by insurance.

The advantages of fire insurance are well-known and generally recognised, and no farmer should be deterred, by the small annual expenditure involved, from securing himself against loss from this cause.

The terms and conditions on which fire insurances in Great Britain are effected by all the principal insurance companies are practically identical, having been settled by a committee representative of about fifty of the leading companies in this country. As some of these conditions, which are of importance to insurers, are not perhaps always understood, the Board believe it will be useful to summarize some of the principal points.

Conditions of Average.

The ordinary condition of average is in the following terms:—"Whenever a sum is declared to be 'subject to average,' if the property covered thereby at the breaking out of any fire be collectively of greater value than such sum insured, then the insured shall be considered his own insurer for the difference, and shall bear a rateable share of the loss accordingly." For example: If property insured "subject to average" is insured for £500, but at the date of a fire is worth double that amount, the insurer will only be able to recover one-half of the damage, whatever be the amount of such damage. If the policy does not state that the property is insured "subject to average," the whole amount of the damage up to the sum of £500 can be recovered.

Agricultural Produce.—In policies of insurance of agricultural produce, including growing crops, fruit, wool, cheese, together with manures, artificial and other food for cattle, a special condition of "average," is generally inserted in the following terms:—

"If the sum insured on agricultural produce, either separately or in one amount with other property, shall at the breaking out of a fire be less than three fourths of the value of all the property insured in that amount, then the insured shall be considered as being his own insurer for the difference between the sum insured and the full value of the property insured at the time of the fire, and shall bear a rateable share of the loss accordingly."

The effect of this condition is as follows:—Suppose the sum insured be £300, and the value of all the agricultural produce insured over the entire farm (together with any other property insured with the agricultural produce in one amount) at the time of the fire to be not more than £400, the clause will not take effect, the sum insured being equal to three-fourths of the full value of the property, and the whole amount of loss up to £300 will be paid; but if the sum insured be £300 as before, and the value £600, the average condition will come into operation, the sum insured being less than three-fourths of the value of all the property on which such sums insured, and the office would therefore only pay one-half the amount of loss, whether that half be £300 or any smaller sum, the insured being his own insurer for the difference and bearing a rateable share of the loss accordingly.

Implements, &c.—In many policies "implements and utensils of husbandry and dead farming stock" are included in one sum with "agricultural produce," and the special average clause then applies to the whole amount.

Growing Crops.—In the absence of any provision to the contrary in the policy, agricultural produce also includes growing crops, and insurers should be careful to bear this in mind, as in a recent case of the destruction by fire of hay and straw in the stack it was claimed by the company, and decided in their favour, that the insurance included growing crops, and that, consequently, under the operation of the special "average" condition it was necessary, in order to obtain payment to the full value insured, that these crops, together with the whole of the other produce, should have been insured to at least three-fourths of their value.

On the other hand, policies on agricultural produce usually are expressly stated not to include:—

1. Hops and grain in any oast or kiln, while fire-heat is being used therein, or in any building adjoining any such oast or kiln, and not separated therefrom by a perfect stone or brick wall; nor barley under process of malting.

2. The contents of any building in which hemp or flax is scutched or dressed, or in which screening of grain by power is done, or in which timber is sawn by machinery, nor the contents of any building adjoining another building, and not separated therefrom by a perfect party-wall of brick or stone, in which any of such processes may be performed.

3. Tanks and vessels (with the material contained therein) for dipping hop-poles, nor farming property within fifty yards of any such tanks or vessels, or within fifty yards of any line of railway, and the value of this property therefore need not be taken into consideration.

Farmers, therefore, in order to get the full benefit of a policy of insurance as regards agricultural produce against risk of fire throughout the year, must insure for not less than three-fourths of the full value of the agricultural produce

immediately after harvest, which may be assumed to be the period when the property on the farm is at its maximum value. *The point to be borne in mind is* that if, on the occurrence of a fire, the valuer appointed by the company estimates the value of the whole of the property insured under the heading of "agricultural produce" at a sum exceeding by one-fourth the sum insured, then the company will probably dispute its liability to pay the full amount of the loss, even though it be less than the amount insured, and only offer a rateable proportion.

If any property insured is declared to be "subject to average," and it does not fall within the special condition above explained, the insurer in order to protect himself fully must insure for the full value of the property in question.

Rates of Insurance on Agricultural Produce.—The insurance of agricultural produce (including growing crops, implements, &c., which are allowed to be insured in one amount), is usually undertaken subject to the special condition of average at a charge of 7*s.* 6*d.* per cent. in England and Wales, and 10*s.* per cent. in Scotland.

Proximity to a Railway.—Some companies require agricultural produce, including growing crops, within fifty or 100 yards of a railway line to be separately insured at a higher rate.

Wool.—Wool is included with other agricultural produce, but it may also be insured separately for a year or for any shorter period, usually at a rate of 3*s.* per cent., subject to the above stated special condition of average.

Hops.—Hops not undergoing any process of drying are included in the item agricultural produce, but hops in farm buildings (excluding hop oasts and stowages communicating therewith for any time during which fires are alight in the furnaces appertaining thereto) may also be insured for any period not exceeding three months at a rate of usually about 2*s.* 6*d.* per cent. Provided such insurance be limited to any specified single building, the policy may be granted without any average condition.

Other Items Separately Insured.—Insurances are also granted on roots not stored in buildings; on growing crops, by separate items; on agricultural produce in any specified single building; and on any specified stock, in each case without the average clause being applied.

Implements and Utensils of Husbandry.

These may or may not be included with the item of agricultural produce, and are charged at the same rate. If included with agricultural produce they become subject to the special condition of average, but not otherwise.

Some companies stipulate that not more than £40 shall be paid for loss on any one article, while others expressly exclude machines worked by steam, gas, oil, electric, water,

or wind power, unless the same be specially mentioned as insured. Farmers possessing machinery worked by power are advised, therefore, to insure it as a separate and distinct item.

Items not Covered by Ordinary Farming Insurances.

As mentioned above, farm produce, and also the contents of any thatched building within 50 or 100 yards of a railway, as well as machinery worked by power, are excluded from ordinary farming insurances. In addition, the insurance does not cover hops and grain drying in oasts or kilns, or in adjoining buildings; barley, under process of malting; contents of any building in which hemp or flax is scutched or dressed, or in which screening of grain by power is done, or in which timber is sawn by machinery, or the contents of adjoining buildings not separated by a perfect stone or brick party-wall; or the tanks, vessels, and material for creosoting hop-poles or other articles, and farm property within fifty yards of such tanks. These items should be insured separately.

Live Stock.

In the case of the insurance of animals on the farm against fire or lightning, the policies of the leading companies provide that if live stock is insured in one item, then in case of loss no animal is to be deemed of greater value than £40; if horses or cattle are insured in an item by themselves, then the limit of value payable in case of loss on each horse, or on each head of cattle so insured, may be raised to £100, but in that case horses and cattle so insured must be excluded from the general insurance on live stock.

If it is desired to insure any horse, bull, ox, or cow for more than £100, or any other animal for more than £40, such horse, bull, ox, cow, or other animal must be specifically described and insured by itself for a stated sum.

Live stock insurance is not subject to "average," that is to say, the farmer can insure his stock for any amount, and not necessarily the full value or any fixed proportion thereof. The insurance covers deaths by lightning. The rate is usually 3*s*. per cent. per annum.

When live stock is to be temporarily removed for grazing purposes to land not included in the farm, the company should be informed, and the fact that they are covered by the insurance recorded on the policy. It may be noted that although insurances may be effected for less than one year, the full annual premium is usually charged.

4, Whitehall Place, London, S.W., January, 1907.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES

Dogs Act, 1906.

(6 EDW. 7, CH. 32.)

The Board of Agriculture and Fisheries desire to call the attention of agriculturists and others in Great Britain to the provisions of the Dogs Act, 1906, which came into operation on the 1st January, 1907, and which should materially diminish the losses incurred by injury caused to stock by dogs.

By section one of the Act the law as to the liability of owners of dogs for injury to "cattle" (which in this Act includes horses, mules, asses, sheep, goats, and swine) is made the same throughout the United Kingdom and renders the owner of a dog liable in damages for injury done to "cattle" by the dog, and deprives the owner of the defence which is popularly known as "the dog's first bite." Stock-owners will also note with satisfaction that the protection afforded by the Dogs Act, 1871, against dangerous dogs is extended by the new Act, and that, under sub-section four of section one, a dog which is proved to have chased sheep or injured sheep or other "cattle" may be dealt with under section two of the Dogs Act, 1871, as a dangerous dog—that is to say, a court of summary jurisdiction may order it to be kept under proper control or destroyed.

Section two empowers the Board to make Orders for the following purposes :—

(*a*) for prescribing and regulating the wearing by dogs, while in a highway or in a place of public resort, of a collar with the name and address of the owner inscribed on the collar or on a plate or badge attached thereto :

(*b*) with a view to the prevention of worrying of cattle, for preventing dogs or any class of dogs from straying during all or any of the hours between sunset and sunrise : and

(*c*) for authorising a Local Authority under the Diseases of Animals Acts to make regulations for either of these purposes.

The Dogs Order* of 1906, recently made by the Board, enables a Local Authority under the Diseases of Animals Acts to make Regulations under (*a*), and prescribes that any dog in respect of which an offence is being committed may be seized and treated as a stray dog under the powers

* Copies can be obtained gratis on application to the Board.

conferred by section three of the Act. No general Order has been issued authorising Local Authorities to make regulations under (*b*), but the Local Authorities of several districts in which sheep-worrying has been prevalent have the matter under consideration. Dog-owners and others concerned will readily ascertain from the local police or from the public notices in their district whether regulations under either (*a*) or (*b*) have been made by the Local Authority.

Section three of the Act gives a police officer power to seize and detain a dog found in a highway or place of public resort which he has reason to believe is a stray dog. Provision is made for notification of the seizure to the owner of the dog where this is practicable, so that the owner may have an opportunity of claiming the dog on payment of the expenses incurred. Registers of the dogs seized are to be kept either by the Police, or at the Dogs' Home to which the dogs are sent.

Under section four, any person who takes possession of a stray dog is required under a penalty of forty shillings forthwith either to return the dog to its owner or to give notice in writing to the Chief Officer of Police of the district where the dog was found.

Section five alters the existing procedure for obtaining a certificate of exemption from the payment of dog licence duty in respect of dogs kept and used solely for the purpose of tending sheep or cattle on a farm. Under the new Act the consent in England, of a Petty Sessional Court, or in Scotland (except in the case referred to below), of a Sheriff or Sheriff-substitute must be obtained before a certificate can be granted by the Inland Revenue. In order to comply with the provisions of the Act, any person claiming exemption must, after obtaining the form of declaration from an Inland Revenue Officer or from a Money Order Post Office, send it filled up and signed, if in England, to the Clerk of the Justices at the Petty Sessional Court House for the place where the dog is kept, or, if in Scotland, to the Sheriff Clerk or Sheriff Clerk Depute at the Sheriff Court House of the County or division in which the dog is kept. Where the declaration is in order, and the grant of the consent of the Court is not opposed, the consent will be granted without the necessity of any appearance at the Court and without any expense to the applicant; it will be endorsed upon the form of declaration which will be sent by the Clerk or Sheriff Clerk to the proper Supervisor who will then grant and forward the certificate to the applicant. The procedure as to these applications is regulated in England by the Dogs Act Rules* made on the 6th December, 1906, by the Lord Chancellor, and in Scotland by the Act of Sederunt* dated

* Copies of the Rules, price 1*d.*, may be obtained, either directly or through any bookseller, from Wyman & Sons, Ltd., Fetter Lane, London, E.C. Copies of the Act of Sederunt, price 1*d.*, may be obtained from Oliver and Boyd, Edinburgh, or through any bookseller.

22nd December, 1906. A list of the applications is to be kept exhibited at the Court House, and a copy of every list is to be sent by the Clerk to the proper Supervisor of Inland Revenue and to the Police. A notice of objection to the consent of the Court being given may be made in England in the form prescribed in the Rules of 6th December, 1906, and in Scotland in the form prescribed in the Act of Sederunt of 22nd December, 1906. Under section eight, the new procedure, so far as it requires the consent of the Sheriff or Sheriff-substitute to the grant of a certificate in Scotland, does not, until the 1st January, 1912, apply to any application for the renewal of a certificate of exemption which was in force on the 4th August, 1906.

Section six enacts that persons who knowingly and without reasonable excuse permit carcases of "cattle" belonging to them to remain unburied in any place to which dogs can gain access shall be liable on conviction to a fine not exceeding forty shillings.

The Board believe that the efficient enforcement of the Act by Local Authorities and the Police throughout Great Britain will reduce the amount of sheep-worrying, and will bring about a better control of stray and ownerless dogs.

4, Whitehall Place, London, S.W.,
January, 1907.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 191.

BOARD OF AGRICULTURE AND FISHERIES.

Cross-Breeding for Mutton in the North of England.

South of England buyers often visit the great autumn sheep auctions of the North, in order to purchase cross-bred lambs and draft cross-bred ewes. Some information as to the manner in which these cross-bred sheep are produced may, therefore, be of value to farmers and others who are interested in the production of first-class mutton.

The greater part of the mutton produced in the four northern counties of England is cross-bred, and the same may be said of that fed in the South of Scotland. The chief reasons for the method of breeding prevailing in these districts are to be found in the mountainous character of the country, the long and often severe winters, and the special suitability of the climate for turnip-growing.

Mountain Breeds.

All the crosses met with in the North of England have their foundation in the mountain breeds : the Cheviot, on the low and verdant Border hills ; the Black-faced mountain sheep (Scotch Black-face), on the higher hills of Scotland, and on the Pennine chain and its spurs running into Northumberland, Cumberland, Durham, and Westmorland ; the Herdwick, on the poor mountain land of Cumberland and Westmorland ; and the Limestone fell sheep of Westmorland.

Of these the Herdwick is the hardiest—possibly the hardiest sheep in existence—and able to get its living throughout the winter on the scanty herbage of the fells, so long as the ground is not covered with frozen snow. Closely following the Herdwick for hardiness are the Black-faced mountain and the Limestone sheep. Without these sheep very little fell farming would be possible, and there would be no means of profitably turning to account the mountain herbage in these districts. But they are small sheep, coarse in the wool, slow in maturing, and too wandering in habit to settle down quietly to feed in small fields and folds ; consequently, as distinct breeds, they are not profitable for stocking tillage farms, which are comparatively highly rented, and on which the production of rapidly-maturing

lamb and mutton is aimed at and quick returns are expected. On the other hand, all three breeds are renowned for the large proportion of lean meat in the carcass, and for the sweet and fine grained quality of their flesh.

The Cheviot has a fleece of fine quality, and is a much tamer sheep than those just described. It is very compactly made, and yields mutton of the highest quality. Of the pure mountain breeds it is certainly the best adapted for fattening on the lowland farms, though it is small in size.

First Crosses.

When these mountain sheep are crossed with any of the large-sized quick-growing breeds, they produce lambs of excellent quality, quickly maturing, and very profitable, either for the butcher or for breeding from as cross-bred ewes.

Border-Leicester—Cheviot cross.—For the first cross the Border-Leicester ram is the one most in favour for use on these mountain ewes in Scotland and the North of England. Like all sheep of the long-woolled breeds—Border-Leicester, Leicester, Lincoln, and Cotswold—it carries far too great a proportion of fat in its carcass; but it is a large, early-maturing sheep, with excellent fleece, and begets good-backed lambs that both grow and fatten rapidly. It has also the important recommendation of having a narrow head, which is inherited by the lambs, and so the difficulty to the small mountain ewes of lambing large lambs is not materially increased by its use as a sire. Where rams of the Down breeds are used, lambing difficulties and losses may occur, owing to the large heads of the lambs.

South country farmers frequently raise the objection to the Border-Leicester—Cheviot cross that the flesh is "sappy" and does not keep well, but this is probably through associating this half-bred white-faced sheep with the pure Leicester and other white-faced breeds that carry so much fat. As a matter of fact the Cheviot so satisfactorily corrects the inferior quality of the flesh of the Border-Leicester as to make the cross one of the best mutton carcasses.

The ewes of this cross are handsome, compact sheep, of good size, with fleeces of the best quality: they inherit the good milking qualities of the Cheviot, are free yeaners—generally bringing twin lambs if in good condition at tupping time—and easily fatten while suckling a pair of lambs. Very large numbers of half-bred lambs and draft ewes of this cross are sold annually at the autumn store sheep sales of Scotland, a large proportion of them coming across the Border, the lambs for winter fattening and the ewes for early lamb-breeding.

Border-Leicester—Black-face cross.—The Border-Leicester—Black-face cross prevails in the adjacent districts of

Cumberland and Westmorland, of which the market town of Penrith is the centre. Some thousands of these "Grey-faced" lambs and draft ewes, as they are locally named, are sold in the Penrith Auction Mart every autumn. These sheep are not so compact in make as the half-bred white-face just described, nor do they carry wool of such good quality; but for good feeding qualities and high-class mutton, with plenty of lean, they would be difficult to beat. The ewes have the excellent milking qualities of the Black-face, and mostly drop couples. Early lambs of this cross, having a little colour in their faces, take the market well.

Border-Leicester—Herdwick cross.—For high-lying tillage farms, the Border-Leicester—Herdwick cross sheep are excellent; their mutton is of the very best, they are hardy and good sized and thrive well, but the ewes are not so prolific as those of the other two crosses, while the fleece is coarser.

Wensleydale—Black-face cross.—A very favourite first cross along the adjacent Westmorland and Yorkshire borders is that of the Wensleydale—Black-face. Sheep of this cross also go by the name of "Grey-faced." The lambs are rapid growers, and the mutton is of high repute, but they fatten more easily when nearly full-grown than as young lambs; they are therefore better adapted for the mutton market than the lamb market. The Border-Leicester sire certainly scores over the Wensleydale as a producer of fat lambs; but the latter has a special value as a sire for a second cross.

Second Crosses.

Coming now to the second cross, the Border-Leicester ram has not much advantage over the rams of other large breeds in the matter of begetting lambs that come easier to the birth; for the first-cross ewes above described are large and roomy enough to give birth quite naturally to fairly large-headed and wide-shouldered lambs. Rams of the following breeds are used on these half-bred ewes:—Border-Leicester, Oxford Down, Wensleydale, Shropshire Down, Leicester, Lincoln, and Suffolk Down. The first-named was at first much more largely used than all the others put together; but the Oxford Down, especially for white-faced cross ewes, is coming rapidly into favour, as may be gathered from the large and increasing numbers sent in recent years to the great ram sales of the North, at Kelso and elsewhere. The plump, dark-faced, close-coated lambs of this Oxford—Border-Leicester—Cheviot cross are great favourites with the butchers, and carry more lean than lambs produced by the use of the Border-Leicester ram a second time; and even on the grey-faced ewes, except when fat lambs are required, the Wensleydale ram is to be preferred to the Border-Leicester.

In fact, the heaviest cross-bred sheep produced in Cumberland and Westmorland are those of the Wensleydale—Border-Leicester—Black-faced breed. For several years in succession at the Penrith Christmas Fat Stock Show the 1st prize pen of shearling wethers were thus bred. These sheep have averaged 230 lb. live weight, and have realised 84*s.* each.

A common practice on the higher arable lands of the Border district is to cross the half-bred ewe with a half-bred ram, bred on identical lines. Fattened during the winter, the lambs of this cross produce carcasses of solid lean mutton in much favour with the butcher.

At the Cumberland and Westmorland Farm School, the ewes used have been (1) Border-Leicester—Cheviot, (2) Border-Leicester—Black-face, and (3) Wensleydale—Black-face ; and the rams Border-Leicester, Oxford Down, and Wensleydale. In the matter of fecundity, the average number of fat lambs actually marketed from the three classes of ewes for six years was 1·7 for each ewe, or about 34 lambs to every 20 ewes—the number born was, of course, higher than this. The ewes have always been in good condition when the rams have been put to them. Of the three kinds, the Border-Leicester—Cheviot have dropped the largest number of lambs, often more than were desired in the way of triplets ; and the Wensleydale—Black-face the smallest number, though the difference has not been great. The lambing period has practically been the month of March.

Lambs from Border-Leicester—Cheviot ewes by an Oxford Down ram have been found to mature quickly. This allows the dams to be sold off fat earlier than the other ewes, thereby realizing better prices, and costing less to keep.

Lambs from similar ewes crossed by a Wensleydale ram showed a growing rather than a fattening tendency in the very early stages, so that they had to be kept longer before they were fat, and in consequence reached heavier weights.

For fat lambs a Border-Leicester ram is generally preferable to a Wensleydale, while for rapidly-growing stores the Wensleydale is to be preferred ; and there will be more lean flesh in those sired by the latter. Lambs from Border-Leicester—Black-face ewes by a Border-Leicester tup have, in certain cases, done remarkably well.

During the past two seasons two other cross-bred ewes have been used with the Oxford Down ram, viz., the Lonk-Wensleydale, obtained from the York and Lancashire Border; and Herdwick—Border-Leicester, from Mid-Cumberland. The former, though fine-looking sheep, proved inferior milkers, and consequently poor nurses for early fat lambs. The latter milked well and supplied the market with particularly good-looking and well-conditioned lambs.

General.

It will be observed that rams of two of the most early-maturing English breeds of sheep have been omitted from the above list, viz., the Hampshire Down and Cotswold. The former has been tried, but is said not to do well in the North, one of the objections being the closeness of the fleece, which is believed to hold the wet too long for the rainy climate of Cumberland and Westmorland. Its high percentage of lean flesh would be a valuable contribution to the qualities of lambs from Leicester cross ewes. The Cotswold would not in the same way improve the quality of the flesh.

The pure breeds of sheep kept in the four northern counties of England and the Border counties of Scotland are the mountain breeds named above, together with Border-Leicesters, and a few excellent flocks of Oxford Downs, and Wensleydales for the production of rams.

Draft Ewes.—The breeders of mountain sheep generally sell their draft ewes to the lowland farmer after three lambings to be mated in good time with a Border-Leicester ram for the fourth lambing. These ewes are then sold fat off good pasture as soon after the lambs are sold or weaned as their condition will allow. The earliest of these first-cross lambs may be sold as fat lambs, and the remainder may be fattened off on turnips as prime hogg (teg) mutton, or wintered well on grass and fattened later for the following summer's mutton market. But the best of the cross-bred ewe lambs are reared for breeding purposes. The wether lambs of the pure mountain breeds are allowed to take their time to grow and fatten on their native fells and do not come into the mutton market except as shearlings or two-shear sheep. A Herdwick two-shear fat wether is by some considered to be the acme of mutton production for quality and flavour.

The system of cross-breeding described in this leaflet may perhaps be found worthy of more extensive application by breeders in other parts of the country, especially in the mountainous and upland districts of England and Wales.

4, Whitehall Place, London, S.W.,
February, 1907.
Revised, September, 1909.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Farm Butter-making.

The manufacture of Devonshire cream and of soft cheeses has already been dealt with in leaflet No. 179*, and in the following pages it is proposed to consider how and when butter should be made on the farm.

It is generally acknowledged that it is most profitable to sell the whole milk, or, failing this, to make cheese and sell cream. It sometimes happens, however, that butter must be made, though this method of utilizing milk on the farm can only be regarded as profitable under certain circumstances, such as :—

(1.) When there is little local demand for whole milk and the distance from a railway station is excessive ;
(2) When the quantity of milk produced on the farm is not sufficient to pay for its carriage by road or rail to market ;
(3.) When the price of whole milk is very low ;
(4.) When the making of cheese or disposal of cream cannot be carried out satisfactorily ;
(5.) When butter can be sold retail at a good price ; or
(6.) When the rearing of young stock is adopted.

Under any of the above circumstances, butter-making may be made a financial success provided other conditions are favourable. For example, it is necessary that the land, water supply, and buildings should be adapted for the purpose of dairying, and that the cattle should be bred, selected and fed with the object of securing rich milk. The separated milk and the butter-milk may be profitably employed either for stock-feeding or for commercial purposes.

Butter Ratio.

Before giving particulars of the butter-making dairy, the term "butter ratio" may be explained. This expression means the ratio of butter produced to the milk used, but is generally understood by dairymen as the amount of milk it takes to make one pound of butter. More butter is obtained by the use of the separator than by setting the milk in shallow pans.

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* Leaflet No. 179 (*Devonshire Cream and Soft Cheese-making*).

The quantity of milk required to produce 1 lb. of butter not only varies considerably with the breed, but, given the breed, it also largely depends on the individuality of the cow. It may be said, however, that the quantity will usually lie within the limits of the following figures :—

Shorthorns, Lincoln Reds, Welsh, Redpolls, Ayrshires	One lb. of butter from 24 to 32 lb. of milk.
South Devons, Kerries, Dexters	One lb. of butter from 20 to 27 lb. of milk.
Jerseys, Guernseys	One lb. of butter from 16 to 22 lb. of milk.

The cattle therefore most suitable for butter-making, assuming that the climatic conditions are not unduly severe, are the breeds of the Channel Islands, or animals obtained by crossing with these breeds.*

To ascertain the quality of the milk, a sample that has been very thoroughly mixed may be sent to an analyst, to a County Council Institution where cheap analyses are made,† or it may be tested at home by the use of the Gerber or some other rapid butter-fat finder. The evening's milk is in nearly all cases richer, or contains a larger percentage of fat, than that given in the morning. The quantity of butter which any given sample of milk is capable of yielding, may easily be calculated when we know the composition of the milk and butter and the loss of fat in the process of manufacture. Assuming for example that butter containing 85 per cent. of fat is manufactured from milk containing 3·6 per cent. fat, and that ·2 per cent. (a usual amount) is lost in manufacture, then from each 100 lb. of whole milk we obtain 4 lb. of butter, as shown in the following calculation :—

$$\frac{(3{\cdot}6 - {\cdot}2) \times 100}{85} = \frac{340}{85} = 4$$

As 4 lb. of butter are made from 100 lb. milk, the butter ratio here is obviously 1 : 25. For butter-making it is desirable to keep cows that give milk containing from 4 to 5 per cent. of butter-fat. The milk of Shorthorns and many other breeds is more readily churned when a small quantity of milk from the Channel Islands type of cattle is added to it. This admixture also improves the colour of the butter.

The Dairy.

Buildings.—There are advantages on the score of sanitation in having the dairy away from, rather than attached to, the

* *See also* Leaflet No. 187 (*Selection and Milking of Dairy Cattle*).

† *See* Leaflet No. 146 (*Tests for Farmers' Milk*).

house or homestead. In either case the building should comprise : (1) A cream-ripening room, where the temperature can be to some extent controlled ; (2) The dairy proper, where the churning is done : the best dairies have a northern aspect, double walls, and a cement or asphalt floor, and are provided with plenty of light and ventilation ; and (3) A scullery or covered yard where provision is made for hot and cold water.

Water Supply.—An ample supply of pure cold water is one of the most important factors in successful butter-making, but rain water is not suitable for the purpose. Any contamination from want of good drainage or other causes means disaster so far as the production of good keeping butter is concerned.*

Utensils.—The following list comprises those articles in general use which are usually kept in the dairy :—

A churn, size according to the amount of cream.
A butter worker.
Two hair sieves.
Butter boards.
Two pairs of Scotch hands.
Butter scoop.
Floating thermometer.
Cream squeegee.
Light steel pails of 12 quart capacity.
One gauged pail.
Set of scales and weights.
Set of measures varying in size from 1 quart to ¼ pint capacity.
Straining cloths.
Butter muslin.
Grease-proof butter paper.
Dry salt.
Set of brushes.
Small railway milk churn for separated milk.
Lime.

In the Cream-Ripening Room.

Enamelled cream pails.
Earthenware glazed crocks for cream ripening.
Shallow setting pans.
An acidimeter for ascertaining when cream is ripe and ready for churning.
Wall and floating thermometers.
Heating stove. Chip boxes.

In the Scullery.

Hand or power separator.
Steel milk pails.
Railway milk churns.
Milk strainer.
Hot and cold water supply.
Floor squeegee, mop and brushes.

Other appliances, which will be found most useful when any considerable quantity of milk has to be dealt with, are a delaiteuse or centrifugal butter dryer, which dries the butter while preserving the "grain" ; a refrigerator or cooler, having a cooling capacity of 120 gallons of milk per hour, which can be used for cooling both cream and separated milk ; a box refrigerator to harden the butter after making, and in which to store it till sold ; a Gerber, Babcock, or other milk tester ; and a dairy herd register for recording the yield of each cow by weight. In practically all cases the most economical method for the removal of cream is the use of the hand or power separator.

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* *See* Leaflet No. 151 (*Cleanliness in the Dairy*).

Preparation of Utensils.—The churn, butter worker, Scotch hands, &c., should be prepared for use in the following manner :—(1) Scald with boiling water, ventilating the churn immediately it is set in motion, and scrub all utensils with a suitable brush ; (2) Rinse with cold water and drain it off ; (3) Rub the inside of the churn with salt, also the worker ; (4) Rinse again with cold water, leaving some on the worker and some in the churn, until the cream is ready to be put in. Wrap a wet butter muslin round the roller of the worker and place another damp cloth over the butter board until ready for use. (5) Before working the butter on the worker drain off all superfluous water, as the worker should only be sufficiently damp to prevent the butter from sticking to it.

Cream Ripening.

Butter can be produced by churning from :—(1) Sweet cream ; (2) Sour or ripened cream ; (3) Ripened whole milk ; (4) Clotted cream. Although sweet cream butter is much appreciated by some people, it is usual in most farm dairies, where churning takes place once or at the most twice a week, for sour cream alone to be dealt with. Cream ripening is brought about in two ways :—1st, by natural means ; 2nd, by the aid of "starters." The natural method is to allow the cream to stand for two, three or four days, according to the weather, in a pure atmosphere at a temperature of 60 to 68 deg. F. Two days in summer and three or four in winter will be sufficient as the general rule. The cream should be stirred frequently and the receptacle containing it covered over with a muslin cloth, when souring or acidifying will take place naturally. The degree of acidity for churning should be about ·5 per cent., this meaning the presence of ·5 per cent of lactic acid.

If required, ripening may be promoted by adding butter-milk at the rate of about half a pint to each gallon of cream. Great care must be taken that the butter-milk used comes only from a churning of really well-flavoured butter.

Starters.—So long as all goes well with "natural ripening" nothing further is recommended. It sometimes happens, however, that the butter produced from naturally-ripened cream is neither high class nor consistent in quality. In such cases it is advisable to pasteurize each lot of fresh cream by heating it to about 150 deg. F., and to ripen by the aid of a *special ferment* or "starter." The method by which this "artificial" system of ripening is carried out is as follows :—

(*a*) The special ferment should be procured from a Dairy Institute or from some reliable firm.

(*b*) One or two pints of separated milk should be heated to 150 deg. F. for 20 minutes, and then gradually cooled to 70 deg. F. The purchased ferment should

then be added (in the proportion directed by the makers) and well stirred in, and the whole should stand in a clean, well ventilated room at about 60 deg. F. to allow the milk to thicken. Thickening should occur in about 24 hours.

(*c*) Next morning another lot of milk (one to two gallons in accordance with the requirements of the dairy) should be taken, and after heating and cooling as directed in (*b*), from a quarter to one pint of the thickened milk (*b*) should be added, well stirred in, covered, and left for a further period of 24 hours.

(*d*) The following morning the "starter" should be ready for use, and a portion of it may be added to the pasteurized cream, the amount varying according to the length of time the cream is required to stand before churning.

(*e*) The starter should be renewed daily in summer and at least three times a week in winter, by following the directions given under (*c*).

(*f*) These special ferments after a time lose some of their vitality, and when this is observed to be the case a new supply should be obtained.

Churning the Cream.

Working Temperatures.—Different lots of cream of varying ages should not be mixed just before churning. Twelve hours at least should elapse from the time of the last addition of fresh cream to a ripened lot before churning takes place. The temperature of the dairy should be noted before work begins. No arbitrary statement can be made as regards the temperature of the cream, as this must depend on the method of feeding the stock as well as other factors. The average temperature, however, at which cream may be churned is perhaps 57 deg. F., but a much lower temperature is required in summer than in winter. In summer it may vary from 52–56 deg. F., and in winter from 56–60 deg. F. or thereabouts.

The following table of temperatures will illustrate approximately what is necessary :—

When the Temperature of the Air is	The Temperature of the Cream should be
Deg. F.	Deg. F.
32–48	61–60
48–52	60–58
52–55	58–56
55–60	56–54
60–70	54–52

It is advisable to use the thermometer frequently at different stages of the work and to record the temperatures under several headings, so that information may be obtained for future guidance :—

(*a*) The Temperature of the Dairy, which will govern
(*b*) The Temperature of the Churn, and
(*c*) The Temperature of the Cream.
(*d*) The Temperature at "Breaking" stage, which will regulate
(*e*) The Temperature of the Breaking Water and
(*f*) The Temperature of the Washing Water, and also
(*g*) The Temperature of the Brine.

When the temperature at which to churn has been decided, the cream may be warmed by standing the pail containing it in hot water not above 120 deg. F., or it may be cooled by standing the pail in water at a lower temperature than the cream. In either case care should be taken to stir the cream during the process. Where ice is not available well water may be used, but if this is not cold enough then brine can be made to reduce the temperature.

Churning.—The cream should be strained into the churn, which should not be more than half filled. The churn should be turned slowly at first, ventilating frequently, and then more rapidly until the speed of the churn is about 55 revolutions a minute. The vendors of the various churns now on the market usually give instructions as to the number of revolutions per minute required for their particular churns. The time taken in producing butter varies considerably, and depends upon the kind of churn used, on the temperature, the ripeness and thickness of the cream, the length of the period of lactation of the cows, and on the concussion produced in the churn. Generally speaking, the butter should "come" in twenty to forty minutes. Churning should cease as soon as the butter "breaks," that is, as soon as the cream is changed into the form of fine grains of butter. This stage is indicated by the clearing of the glass window in the lid, and by the dull thud of the "broken" cream falling inside the churn. If doubt is entertained as to whether this stage has been reached, the churn may be opened and the condition of the cream observed.

Should the cream become "sleepy" water should be added to thin it down and regulate its temperature. Cream usually gets into the "sleepy" condition after about 25 to 30 minutes churning if it becomes so at all. In most cases washing the lid and sides of the churn with water at from 65 to 75 deg. F., will cause the butter to come quickly and without any bad result, as when the butter comes the subsequent washing with water cooler than the butter milk will rectify any harm that may have been done in making the grain soft.

When the butter comes, a quart or so of cold breaking water should be added for each gallon of cream in the churn, and then churning continued until the butter grains are of the required size. The best size is, on the average, about that of small wheat. In no case should the butter be churned into lumps, or curd will be enclosed, and as it is impossible to wash this curd out, the keeping qualities of the butter will be greatly impaired. The butter-milk should be drawn off through the hand sieve over which a piece of muslin has been tied.

Washing and Salting.

The temperature both of the washing water and of the butter inside the churn should be taken at this stage. To harden the grain the temperature of the water should be reduced; to soften the grain the temperature should be raised a few degrees. In the latter case, however, great care must be taken or the butter may be churned into lumps.

Two washings are usually sufficient to get rid of most of the casein, but if a third is given the keeping qualities are improved. Brine is made by dissolving salt at the rate of 1 to 2 lb. in each gallon of water. The butter grains are usually allowed to soak in the brine for about twenty minutes, although a much shorter time is perhaps equally effective so far as salting is concerned. Complete immersion of the butter is necessary. The butter should be removed by means of a scoop and sieve from the brine to the drier or worker as the case may be.

When salt butter is made dry salting is the method usually adopted. The salt used should be fine, dry and clean, and added to the butter grains on their removal from the churn to the butter worker before the roller is brought into use. In order to obtain mild salt butter $\frac{1}{4}$ oz. of salt per 1 lb. of butter may be employed, while for medium salt butter $\frac{1}{2}$ oz. of salt will be required.

Working.

Where a centrifugal drier is used the butter is taken from the churn and put into the bag of the drier for drying in the machine. This process occupies perhaps two minutes. The butter is then turned out on to the butter worker, where one or two turns are sufficient to get it together. By this means the grain of the butter is preserved.

Where a centrifugal drier is not available, the butter grains having been removed from the churn to the worker by means of the perforated wooden scoop, working may be commenced. In hot weather a damp cloth should be placed over the butter, and it should then be left to harden in the coolest place available. In some cases it is best left in brine in order to harden. The object of "working" is to get rid of the moisture, by means of pressure, with as little

injury to the grain as possible. Great care is needed in the operation, for well-churned butter is frequently spoiled by the rough and clumsy use of the roller at this stage. The law permits a maximum of 16 per cent. of water in butter, but this quantity would be considered excessive in most farm-made samples. The amount of water present in well made butter is usually no more than 12½ per cent.

Making Up and Marketing Butter.

Scotch hands are employed in making up the butter into various shapes, such as bricks, rolls and fancy forms. A pound print of a useful packing size measures about 4½ inches by 2½ inches by 2½ inches. A neatly made block of butter with square ends and printed with some fancy design is perhaps the most attractive form of make up, and when neatly made up and presenting an attractive appearance obtains a better price. After butter is made up it should be put in a cool place for a short time to allow it to harden before packing. Chip or card boxes, which can be bought very cheaply, are useful for packing purposes. The butter should first be wrapped in grease-proof paper and then inserted into the box, on which may be printed the name of the maker or some attractive title. When a good article can be manufactured and the product turned out of uniform quality throughout the year, a satisfactory price will usually be obtained, as there is always a good demand for well-made farm butter.

Colouring and Preserving of Butter.

If the milk of ordinary cows has mixed with it a proportion of milk from Channel Islands cattle both the colour and flavour of the butter will be improved. Farm butter that has been well washed and worked in the granular stage to expel as much moisture as possible, will keep good for a considerable time, say from ten days to a fortnight in summer and up to six weeks in winter, if stored in a cool place.

Potting Butter for Winter Use.

Butter that is to be potted down should be made from slightly ripened cream, treated in the way described above. One oz. of dry salt must be added to each pound, and the butter very thoroughly worked, in order to get it as dry as possible. Salt butter is packed in well cleaned glazed crocks, and must be well consolidated. After being well pressed down it should be covered with a thick layer of salt, or, better still, with brine. A piece of parchment paper should be tied tightly over the crock, which should then be stored in a cool dry place. Butter so treated will keep for several months. On removal it should be soaked for some time in water of about 65 deg. F., re-worked, and then made up. In re-working it should be sprinkled with cold water, which will freshen the butter and reduce the saltness.

Judging Butter.

The scale of points used in judging butter varies considerably, but the following may be accepted as a useful one :—

General appearance, including neatness of make-up and finish, 15 ; colour, 5 ; texture, 20 ; freedom from moisture, and, where butter is salted, evenness of salting, 20 ; flavour, 30 ; aroma, 10. Total, 100 points.

Washing Up.

All utensils should be well washed with warm water to remove grease. The churn should be scalded with boiling water and ventilated on first and subsequent revolutions, the rubber band being removed from the lid and all metal parts of the churn oiled, while the ventilator should be taken to pieces occasionally and the parts carefully cleaned. The butter worker often becomes sticky, and the rolling of the butter is then made difficult and unsatisfactory, as the butter sticks to the wood. As a remedy the wooden parts should be washed with soda, or scrubbed with finely-ground lime. If the wood becomes rough through wear the worker should be taken to pieces and the wood carefully planed along the grain.

Note.—Other leaflets which may usefully be read in connection with the present leaflet, are the following :— No. 146 (*Tests for Farmers' Milk*) ; No. 151 (*Cleanliness in the Dairy*) ; No. 179 (*Devonshire Cream and Soft Cheese-making*) ; and No. 187 (*The Selection and Milking of Dairy Cattle*).

4, Whitehall Place, London, S.W.,
August, 1907.
Revised, December, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

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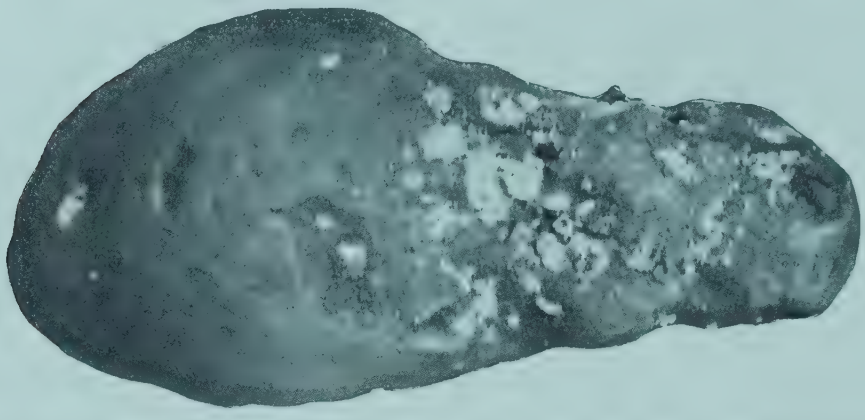
Leaflet No. 193.

BOARD OF AGRICULTURE AND FISHERIES.

Winter-Rot of Potatoes (*Nectria solani*, Pers.).



WINTER ROT (*Nectria solani*). Diseased tuber showing white tufts of the fungus, the condition most usually seen. The right-hand end is considerably shrivelled.

This fungus causes one of the commonest diseases of the potato. It attacks stored potatoes, and is always present to some extent, but usually only reaches the proportions of an epidemic during hot, dry seasons, which favour the rapid development and spread of the fungus. The tubers only are attacked, and inoculation, by spores present in the soil, takes place when the tubers are young; but, as a rule, the disease is not obvious when the tubers are lifted, although the mycelium of the fungus is present in the tissues. The further extension of the disease depends entirely on circumstances. If the potatoes are kept dry and exposed to the air no further development takes place. On the other hand, if they are stored or placed in heaps so that air is practically excluded, and more especially if stored before being perfectly dry, sweating takes place, the temperature is raised, and within a few weeks the mycelium present in the tubers commences growth.

During recent years the disease has become more evident when the crop is lifted; many tubers at that time show the advanced stage of the disease and are usually considered to be too badly diseased to be gathered. Such tubers, left to decay on the land, endanger future crops. This extension of the disease is probably due to slightly diseased tubers being used as "seed."

In certain instances the disease called "Sprain" has proved to be an arrested condition of Winter-Rot.

Description and Life History.

The first external indication of disease is the gradual depression and shrivelling of a portion of the surface of the tuber; these sunken portions are soon more or less covered with white patches of the fungus, bearing myriads of spores, which are quickly distributed by mites and other minute creatures.

At a later stage the white tufts change to a pale pink colour, and produce a second crop of spores, which in like manner are distributed through the heap of potatoes by mites, &c. By such means the disease quickly spreads, and, aided by bacteria, the tubers are soon reduced to a soft, fœtid mass, the skins alone remaining intact.

During the following season the most perfect stage of the fungus, in the form of minute crimson-red points, develops on the skin of diseased tubers. The spores of this stage germinate in the soil and infect future crops.

Prevention and Remedy.

1.—The best preventive against an attack of winter-rot is to make certain that the potatoes are well dried before storing. Powdered sulphur, if sprinkled over the tubers at the rate of 2 lb. to the ton, will destroy the fungus and also hold in check mites, woodlice, &c., which, by their movements, convey the spores from one potato to another. "Pits" or "clamps" should always be well ventilated.

2.—Land that has produced a diseased crop will certainly be infected, and potatoes should not be planted in it again for some years. Kainit, or lime, may be applied to infected land. Both destroy the spores at the moment of germination, and also mycelium present in the soil. The former is the more effective, and when land is infected this manure should be used in preference to sulphate or muriate of potash; but the quantity should not exceed 5–6 cwt. per acre, or the quality of the potatoes may be injured. Kainit may be applied in the drills before planting; but in this case, where it is required both as a fertiliser and a fungicide, it would probably be better to apply half of it as a top-dressing before the horse-hoe is used for the last time.

If the land needs potash, and especially if the potato crop is to be followed by a crop likely to be benefited by potash, as *e.g.*, barley or mangolds, a dressing of kainit may be applied to the infected land as soon as the potatoes have been lifted. If potash is not required, and if the land is likely to be benefited by lime, then it would be desirable to dress the affected field with from 1 to 3 tons of lime per acre. In connection with the liming of land Leaflet No. 170 should be consulted.

4, Whitehall Place, London, S.W.,
August, 1907.
Revised, April, 1910.

Leaflet No. 194.

BOARD OF AGRICULTURE AND FISHERIES.

Coltsfoot. (*Tussilago Farfara*, L.)

One of the common weeds about which farmers make frequent enquiry is coltsfoot or foal's foot (*Tussilago Farfara*, L.), as it is sometimes called.

Description.

The flowers of the plant are among the earliest to bloom in spring, being generally seen in February and March. The stalks bearing them usually grow from four to ten inches high, and are clothed with small scale-like leaves (Fig. 1).

At first the flower heads droop, but when they open out they are erect. At night or in dull weather they close up, but expand in bright sunshine. Each head consists of yellow flowers arranged on the same plan as those in a daisy, having a central collection of small florets—the "disk" florets—and an outer rim of "ray" florets. The "disk" florets, which occupy the central parts of the flower head, are about thirty in number. Each has a small tubular corolla with five regular divisions or segments. Stamens which bear pollen are present, and there is also a thickish, blunt stigma attached to the ovary below. Although stamens and pistil occur together in them, these flowers rarely, or never, bear fertile seeds. Honey is produced by the flowers, and flies, bees, and other insects pay visits to them for it.

The outermost "ray" florets, of which there are from 200 to 300 in each head, are irregular, with a narrow strap-shaped extension of the corolla. They are female only, having no stamens and therefore no pollen. The stigma, which is divided at the top, projects a short distance from the tube of the corolla. It is protruded, and ready for the reception of the fertilizing pollen before the central florets of the same flower head are open, so that fertilization, if it is effected at all, is brought about by pollen which has been transferred to it by insects from older distinct flower heads.

Cross-fertilization is the rule, and fertile seeds arise in the ovaries of the "ray" florets. Each ripened fruit or "seed" is a thin elongated structure, orange-red in colour, and bears at its apex a bunch of white fluffy hairs or down called the pappus, just as in thistle "seeds." The leaves, when fully developed, are generally from four to eight inches across, roundish or heart shaped, downy beneath and with a few marginal teeth. In shape they bear a fanciful resemblance to the foot of a colt, hence the name of the plant (Fig. 2).

Life History.

The "seeds" are carried about by the wind, and spread over the land in the neighbourhood of the parent plants.

They only germinate readily under shady conditions in loose, damp soil, or on ground covered with herbage, between the leaves of which the seeds ultimately find their way when they settle. In dry situations or on smoothly-pressed soil they germinate very irregularly or not at all.

FIG. 1.—COLTSFOOT BEFORE LEAVES APPEAR.

The seedlings are remarkably small, with two very narrow cotyledons. After a week or two the first broad, somewhat heart-shaped leaf appears (Fig. 4). Coltsfoot is a perennial weed and flowering does not take place during the first season.

The blooming of the first flowers and the sowing of the seeds occur very commonly before the leaves of the plant are sent above ground, a peculiar feature which it is essential to emphasize. The flower heads come up singly or three or four together from an underground root-stock; after they have been developed some time the leaves begin to appear. These arise from underground buds of the root-stock, distinct from those out of which the flower heads arise (Figs. 1, 2 and 3).

The rootstock branches below the surface of the ground and extends to very considerable depths. It has been traced vertically downward in stiff clay to a depth of three or four feet (Fig. 2). Coltsfoot is commonly confined to stiff, damp soils, and more especially to those containing lime or marl, although it is sometimes met where lime is not abundant.

Prevention and Remedy.

1. Very frequently no attempt is made to get rid of this pest until its conspicuous broad leaves become an eyesore to the farmer. It, is, however, essential to check seeding, and the plant should be spudded or hoed out while in

FIG. 2.—LEAVES AND RHIZOME OF COLTSFOOT.

FIG. 3.—COLTSFOOT PLANT JUST AFT "SEEDING."

flower. This prevents the mischief due to the distribution of ripe seed, and if properly done many of the leaf-buds on

the root-stock just below the surface of the soil are damaged, weakened, or destroyed at the same time.

2. Repeated spudding or hoeing of the leaves must be practised early in the season, and also later in the year, as recommended in Leaflet No. 166 (*Some Common Thistles*) for creeping thistle. This practice is especially necessary where the plant is established on arable fields.

3. Wherever possible the ground should be dried by

FIG. 4.—COLTSFOOT SEEDLINGS.
SIX DAYS TO THREE WEEKS OLD (Natural size).

well-placed drains. The plant does not succeed except where the soil is stiff and retentive of moisture.

4. Coltsfoot grows best, and is especially adapted to thrive, in situations where the leaves have free, unrestricted exposure to sunlight. Hence it succeeds on poor soils where other plants are checked, the absence of competition favouring its access to light. On arable land kept free from other weeds it luxuriates especially.

5. In pastures and meadows it can be gradually destroyed by the application of manures of a nitrogenous character—farmyard manure, nitrate of soda, and similar materials—which encourage grass and other tall-growing herbage.

6. Deep ploughing in the hotter periods of summer does much to destroy it.

The damage done by weeds generally is fully described in Leaflet No. 112 (*Weeds and their Suppression.*)

4, Whitehall Place, London, S.W., June, 1907.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 195.

BOARD OF AGRICULTURE AND FISHERIES.

American Gooseberry Mildew (*Sphaerotheca mors-uvae*, Berk.).

The disease known as American Gooseberry Mildew, *Sphaerotheca mors-uvae*, is of a very serious character. It has greatly increased the cost of the cultivation of gooseberries in the countries in which it has appeared, and in some cases it has rendered gooseberry-growing impossible.

This fungus is much more injurious to gooseberry bushes than the allied European Gooseberry Mildew, *Microsphaera grossulariae*, Lev. (Leaflet No. 52), as it not only attacks the leaves, but also extends to the shoots and fruit, stunting the latter and rendering it unsaleable.*

In this leaflet there is given (1) such a description of the fungus as will aid fruit-growers to recognise the disease should their gooseberry bushes be found to be attacked, (2) precautions to be observed by gooseberry growers, and (3) instructions for the treatment of infected bushes.

Description of the Fungus.

There are two well marked stages in the life of this fungus: in the first stage it is white; in the second stage it is brown. The white stage always comes first, but the brown is more easily seen and is often the first to attract attention. The white form of the mildew, usually called the summer stage, may appear at any time between May or November, while the brown stage, known as the winter stage, may be seen from July onwards. During the winter months the brown colour gradually changes to grey. (*See Coloured Plate.*) While in the white stage the mildew produces vast numbers of minute spores. (The spores of fungi correspond to the seeds of higher plants.) These spores are carried about in various ways, and if they fall on the opening buds or young fruit of a gooseberry bush they begin to grow at once. In this way in warm and moist weather the mildew may spread very rapidly; but fortunately for fruit growers it does not always spread rapidly. The young shoots are the parts attacked, and the mildew is always worst on young, vigorous, growing bushes, and especially on cuttings. The summer spores though numerous are short-lived, and in cool, dry weather they seem to be incapable of doing much mischief.

* Occasionally the English mildew assumes a virulent form and attacks the fruit.

AMERICAN GOOSEBERRY MILDEW (*Sphaerotheca mors-uvae*).

1.– Early or "summer" stage on leaf (nat. size); 2. Early or "summer" stage on young shoot (nat. size); 3. Diseased berries on previous year's shoot with unaffected leaves (nat. size); 4. Affected leaves and shoot, showing "chocolate" or second stage on the latter (nat. size); 5. Grey or "winter" stage, showing winter fruits or perithecia as black dots (enlarged).

If gooseberry mildew were to depend on the short-lived summer spores it could not exist throughout the winter; very soon therefore, a second kind of spore begins to form. This spore is known as the winter or resting spore. The fungus is thus more difficult to check than an ordinary weed, which produces only one kind of seed, and the difficulty is increased by the character of the winter fruits inside of which the spores are found.

Before forming winter spores the mildew changes colour and assumes a deep brown tint, so that badly affected twigs look as if they had been smeared with chocolate. If infested twigs are thereafter examined with a magnifying glass minute black dots called winter fruits will be seen. The winter fruits are shown in Figure 5 of the coloured Plate. Each winter fruit consists of a strong shell, inside which are eight spores. The shell protects the delicate spores throughout the winter and does not open until spring growth begins. From the course which the disease runs in this country, it would appear that the fruits begin to liberate the resting spores early in May, but that the majority burst in June or July. Some winter fruits remain attached to the infected twigs throughout the winter, but the greater number fall off and lie in the soil. Most of them burst and release the infectious spores in the following summer, but there is reason to believe that they may lie dormant for about eighteen months.

Conditions under which Disease occurs.

American Gooseberry Mildew attacks soft quick-growing shoots; thus suckers, and the shoots produced in warm moist weather, are much more liable to infection than firm slow-growing shoots. This explains a feature of the disease which often puzzles growers. When a new district is attacked, the first plantations to suffer are those which have been highly manured and carefully managed. The large, quick-growing bushes produced by such treatment are found to be much more liable to attack than the poor plants in a neglected garden.

Some varieties of gooseberry are naturally more vigorous than others and thus produce more young wood in the late summer and autumn; these varieties are found to be most affected by mildew. For example, the quick-growing varieties "Keepsake," "White Lion," and "Crown Bob" contract disease to a greater extent than the slow-growing varieties "Whitesmith," "Careless" and "Long Swan." Apart from the rate of growth and the nature of the new shoots produced, varieties do not seem to have any special capacity for resisting disease. Thus "Golden Drop" is not so liable to attacks on the young wood as most other varieties, but the berries, which happen to have a soft skin, are more

apt to suffer from mildew than those of any other kind. In most varieties disease does not appear to be able to attack the berries after they are half grown, but in "Golden Drop" full grown berries may suffer.

Deep, porous soils produce tall, vigorous plants, while shallow or stiff soils produce small bushes, so that disease is more troublesome on the former than on the latter class of soil. When, associated with deep porous soils, there is an abundance of moisture, as in the silty soils of the Wisbech district, the conditions are specially favourable for the spread of mildew. In gardens in all affected districts variations in the depth of the soil, and in the amount of moisture, account for the unequal distribution of disease throughout infected plantations.

Precautions to be observed by Growers.

Although there are many infected gardens in certain districts, and although infection may doubtless be conveyed by wind, birds, insects and other means which are outside a grower's control, it does not follow that it is useless to take precautions against infection. Even in Worcestershire, where the disease has longest been known to exist, by far the greater number of gardens are free, and of those infected a comparatively small number are badly attacked.

Again, as has already been stated, the disease does not always spread rapidly, and in many of the cases in which it has suddenly appeared all over a plantation there has been reason to suspect that the plantation had been affected for some time without attracting attention. On the other hand, in many of the cases in which the mildew has been discovered early and prompt action has been taken, disease has not spread throughout the plantation.

When the disease is neglected and allowed to spread all over a garden, the cost of treating it is heavy, and in many of the worst cases it pays the owner better to grub up the plantation than to attempt to cure the affected bushes. It is quite clear therefore that it is worth a fruit-grower's while to take precautions to prevent infection, and to prevent disease from spreading if his garden should unfortunately become infected.

Fruit-growers are recommended to observe the following precautions;—

(1) Plants should not be purchased from nurserymen or dealers unless a guarantee is given that they are free from American Gooseberry Mildew. Young bushes should be cut back before being planted and the prunings burned.

(2) So many cases have been found in which disease has begun on bushes close to the packing sheds or other places near which "empties" have been stored, that baskets, barrels, sacks, &c., which may recently have been in a

A branch from a gooseberry bush showing berries badly attacked by American Gooseberry Mildew.

diseased garden should be treated with suspicion. Empties sent by salesmen for carrying fruit of any kind to market should not be taken direct into gooseberry plantations. They should first be disinfected. Baskets may be disinfected by dipping them in boiling water or in a solution of 1 lb. bluestone (copper sulphate) to 20 gallons of water; sacks may be scalded. Even if disinfected, packages should not be taken into fruit-plantations until actually required. As already stated, the summer spores of mildew do not live long, and every day's delay in bringing baskets near gooseberry bushes makes the risk of infection less.

(3) Labourers who have been working in a garden in which the disease exists in its summer stage, should not be set to work in a clean gooseberry plantation for a week at least, unless means have been taken to disinfect their clothing.

(4) Growers should make a practice of searching their plantations for traces of disease at frequent intervals, especially in the months of July, August and September. Young leaves which are attacked generally curl upwards and show a white under-surface covered with mildew. Pickers should be told to report at once any cases of mould on the berries. As indicated above, outbreaks of disease in plantations in which mildew has not previously appeared are very often found near packing sheds, so that special care should be taken in examining bushes near the places where gooseberries, plums, &c. have been got ready for market.

(5) As disease may appear at any time between May and November, fruit-growers should keep on their premises a few pounds of liver of sulphur. This substance when freshly made up, as explained below, is the best spraying material for summer use. A good quality should be procurable at 6d. per lb. It must be kept in an air-tight tin or a corked bottle, for if exposed to air it quickly loses its value. A spraying pump should also be kept in readiness. The common knapsack sprayer costing about 35/- would serve for ordinary plantations, or a hand-pump of the syringe pattern costing 7/6 to 15/- might be used in small gardens.

Treatment of a first Outbreak.

Assuming that a watchful fruit-grower discovers the disease as soon as it gets into his plantation, he should at once remove and destroy the affected berries or shoots; they may be collected in an iron bucket and burned, or dipped into a "steep" made by dissolving 1 lb. liver of sulphur or 1 lb. bluestone in 10 gallons of water. A spraying mixture should then be made up of 1 lb. liver of sulphur to 32 gallons of water, and the affected bush and surrounding bushes should be thoroughly sprayed. Those who do not possess a spraying pump should thoroughly soak the bushes by means of an ordinary syringe, or a watering can. After the spray has

dried, the affected bushes should be dug up and burned, or the young wood should be removed. If many twigs or berries are covered with mildew when the disease is first observed, the bushes should be sprayed before any attempt is made to remove the diseased material.

In treating American Gooseberry Mildew the first essential for success is prompt action. Since the spread of the infection may be very rapid, it is recommended that where very little mildew is to be seen, it should be cut off and destroyed immediately. The shoots removed must not be carried through the plantation. They may be destroyed as indicated above, or buried below the bush from which they have been taken, and covered with several inches of soil; only twigs affected by the white stage should be thus covered up: the brown stage of the fungus must always be destroyed by burning, never buried in the soil. When many twigs have become diseased there is much danger of spreading the mildew while working among the bushes, and the bushes should therefore first be sprayed. The spray will destroy much of the mildew, and the risk run by working among the bushes will be greatly reduced.

On any bush upon which mildew has been seen, and also on the bushes in contact with the diseased plant, there will probably be a number of recently infected twigs, which will bear no visible traces of disease. Thorough spraying will do much good, but as it is very difficult to ensure that the spray wets every part of a bush the safest plan is to remove and burn the infected and suspected bushes as soon as possible after the mildewed twigs have been destroyed as recommended above. If this is not done the bushes must at least be very carefully pruned so as to remove all young wood that may be infected.

In the above recommendations it is assumed that spraying materials are at hand; should this not be the case a bucket containing paraffin should be procured, and all diseased material should be removed, dipped in paraffin and burned at once. It is better to risk the danger of spreading infection by working among unsprayed bushes than to delay for a day the work of destroying diseased twigs.

It must be clearly understood, however, that the above advice refers to slight outbreaks affecting a few bushes which could be dealt with single-handed by a careful man. It would be most unsafe to turn a number of labourers into an affected plantation to root-up and burn bushes suffering from disease in the summer stage until the plantation has been disinfected by spraying.

As soon as the fruit grower has dealt with the diseased bushes he should spray the whole of his gooseberries and currants with liver of sulphur, and repeat the dressing in a week. The spray for general use should be made up of

1 lb. liver of sulphur to 32 gallons of water. A stronger spray, say 1lb. liver of sulphur to 24 gallons of water may safely be used after July. It has been found that the spray wets the mildew and sticks better if soft soap is added to the wash at the rate of 1–2 lb. for 32 gallons of water.

If there is no fruit on the bushes Bordeaux mixture is better than liver of sulphur. A convenient formula for fruit-growers who usually make Bordeaux mixture in a paraffin cask is 4 : 4 : 40, *i.e.*, 4 lb. of freshly burned lime and 4 lb. of bluestone (copper sulphate) to 40 gallons of water. To make Bordeaux mixture 4 lb. of lime should be weighed out, moistened and allowed to slake ; when the lumps have fallen to powder the lime should be stirred up in 2 to 3 gallons of water to make "milk of lime," and then strained through a piece of coarse sacking into the cask, which should then be filled with water to within 2 or 3 inches of the top. The whole should be stirred for a few minutes and then the lime should be allowed to settle for half-an-hour. The 4 lb. of copper sulphate should next be dissolved in from half a gallon to a gallon of boiling water (this must be done in an earthenware or wooden vessel) and poured into the cask. The mixture should be stirred gently, but not so as to disturb the sediment at the bottom of the cask. The Bordeaux mixture is then ready and should be used while fresh.

Treatment of Diseased Plantation.

By adopting the line of treatment indicated above, the chances of stamping out the disease are good, but if from neglect or any other cause a garden has become generally infected with disease a different procedure will be required.

It is impossible to say what is the best course to adopt in any particular garden, for once the disease has become widespread the treatment, to be successful, must vary according to the time of year, the weather, and the condition of the bushes. In general terms, however, it may be said that the grower's object must be to check the spread of the disease as much as is practicable while it is in its summer stage, and to cure it when it has passed into the winter stage. For advice in dealing with bad outbreaks the grower is recommended to consult one of the Inspectors of the Board or of the Local Authority. Inspectors are always glad to assist growers.

Two methods may be adopted in treating the summer stage, (1) Spraying, and (2) Removal of the diseased tips. The first remedy is the best in the early part of the season, up to about the end of July, while the second is the more effective from the middle of August onwards.

There is no doubt that a spray of liver of sulphur checks the disease if the spray soaks the mildew and dries

upon it, but unfortunately it is difficult to ensure that the somewhat greasy surfaces of mildewed twigs are soaked with spray, and even when the twigs have been wetted a fall of rain frequently washes off the spray before it has had time to dry. In practice, therefore, it is found that spraying, to be successful, must be frequent. Regular spraying is of special importance when the mildew appears early in the season, when young bushes in nurseries are attacked and when disease breaks out in a new district. In all cases in which neighbouring plantations are endangered by the presence of mildew, spraying must be resorted to.

As soon as active growth stops, growers should begin to remove and burn every twig showing disease. This is a valuable means of checking the spread of mildew in the early autumn. If begun too soon, however, bushes throw out many fresh shoots, and the soft tips so produced are very liable to infection. After the middle of August the buds would seldom "break," and in the case of old bushes growing on poor dry soil the removal of the tips may safely begin early in July. All diseased tips must in any case be removed by a date specified in the notices served under the Board's American Gooseberry Mildew Order, and the sooner this can be done the better for the grower himself.

On diseased twigs in the early autumn mildew is found in both the summer and winter stages. Twigs showing the summer stage are highly infectious, and if they are removed many adjacent bushes will be saved from disease; further, the summer stage soon changes into the winter stage, so that even if the grower does not remove the diseased wood in August he will be forced to do so a month or two later. He has therefore little to gain and much to lose by delaying the removal of the tips of gooseberry shoots affected by the summer stage of the disease.

As regards twigs suffering from disease in the winter stage there is also a good reason for their early removal, for the winter fruits begin to drop off the bushes and to infect the soil a few weeks after they are formed. If, for example, mildew attacks a crop in the middle of July, the winter fruits may begin to drop off by the end of August. The only chance the grower has of curing a bad attack of mildew is to destroy the winter fruits, and if he wishes to do so he must begin pruning in good time. It is true that a number of winter fruits remain attached to the wood, so that by pruning even as late as February he is *reducing the risk of a severe attack* in the following summer; but if he does not begin his work *early* so as to prevent the winter fruits dropping into the soil, it is very unlikely that he will effect *a cure*; the chances are that he will have the whole of the work to do over again in the following summer.

Fruit-growers are busy during the early autumn months and labour is difficult to obtain, but in view of the dangers entailed by delay, strenuous efforts should be made to remove diseased tips in August and September. In any case the suckers which grow in an affected plantation must be pulled up and destroyed, as suckers are very liable to contract disease.

Diseased tips should not be allowed to fall on the ground, but should be thrown into iron buckets, or baskets lined with sacking, as soon as they have been pruned off the bushes. As a further precaution against re-infection, the soil of gooseberry plantations should be dug over in winter and the surface buried as deeply as possible.

NOTE.—American Gooseberry Mildew is a scheduled disease under the Destructive Insects and Pests Acts, 1877 and 1907. Every person who has on his premises any gooseberry or currant bushes which have been or are affected with the disease, or are suspected of being affected, is obliged to report the fact to the Board of Agriculture and Fisheries, to the Local Authority for the district, or to one of the Inspectors of the Board or the Local Authority. The penalty for the neglect to report is £10. Full information is given in the American Gooseberry Mildew Order of 1909.

4, Whitehall Place, London, S.W.,
May, 1907.

Revised, November, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 20 leaflets dealing with Fungi injurious to Farm and Garden Crops may be obtained from the same address, price 1d., post free.

BOARD OF AGRICULTURE AND FISHERIES.

Fertilisers and Feeding Stuffs Act, 1906.*

[6 EDW. 7. CH. 27.]

The Board think it may be useful to issue a leaflet summarising the principal amendments of the law relating to fertilisers and feeding stuffs which were effected by the Fertilisers and Feeding Stuffs Act, 1906. This Act, which supersedes the Fertilisers and Feeding Stuffs Act, 1893, came into force on the first day of January, 1907, and embodies certain recommendations made by the Committee appointed in 1903 to enquire into the working in Great Britain of the Act of 1893.

Amendments effected by the new Act.

The principal amendments of the Act of 1893 are as follows :—

(1) The actual percentages, and not merely the minimum percentages, of nitrogen, soluble phosphates, insoluble phosphates, and potash must be stated in the invoices of fertilisers which have been subjected to any artificial process in the United Kingdom or imported from abroad.

(2) The Act applies to sales of fertilisers however small the quantity sold.

(3) Statements of the percentages of chemical and other ingredients in any article sold for use as a fertiliser, whether contained in the invoice or in an advertisement or circular descriptive of the article, will have effect as warranties; but, in the case of statements in an invoice as to percentages of nitrogen, phosphates, and potash, the extent of the warranty is affected by the "limits of error" which are prescribed by Regulations which have been made by the Board.

(4) In the case of any feeding stuff artificially prepared otherwise than by being mixed, broken, ground, or chopped, the invoice must state the percentages of oils and albuminoids.

(5) Provision is made for analysis by the official agricultural analyst of samples taken without any communication of the fact to the seller.

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* Copies of this Act may be obtained from Wyman & Sons, Ltd., Fetter Lane, London, E.C.; Oliver and Boyd, Edinburgh; or E. Ponsonby, 116, Grafton Street, Dublin. Price 1½*d.*

(6) Local Authorities are authorised to appoint official samplers who can take samples of any fertiliser or feeding stuff without the consent of the owner.

(7) Provision is made to secure sellers from unreasonable prosecutions, and for prescribing by Regulation the "limits of error" within which they will be free from civil liability in respect of the statutory warranty arising from the statement of percentages contained in invoices.

(8) The Act applies to foods for poultry as well as foods for cattle, sheep, goats, swine, and horses.

Regulations under the Act of 1906.

The Board of Agriculture and Fisheries have made and issued three sets of Regulations* under the Act. These Regulations came into force on 1st January, 1907, from which date the Regulations made under the Act of 1893 were revoked. The new Regulations comprise :—

1. Fertilisers and Feeding Stuffs (Sampling, &c.) Regulations, 1906.
2. Fertilisers and Feeding Stuffs (General) Regulations, 1906.
3. Fertilisers and Feeding Stuffs (Limits of Error) Regulations, 1906.

Sampling, &c., Regulations.—These Regulations do not differ to any great extent from the revised sampling Regulations of 1897. A few alterations were necessary in consequence of the amendment of the law. The Act of 1893 required three samples to be taken [section 5 (2)], but under the Act of 1906 one sample will be taken and it will in certain cases be divided into three parts [section 3 (3)]. This being the case, and in view of the importance of obtaining a fair representative sample, the weight of the sample to be taken has, as a rule, been trebled. The number of cakes to be taken in sampling a consignment of cake has also been somewhat increased so as to ensure that a fair sample shall be taken. Special provision is made for the case of consignments not exceeding 2 cwts. (*see* Regulation 6 (*b*) (xi)).

It has been considered desirable to prescribe the part of the invoice which is to be sent to the chief analyst or to the agricultural analyst, where the purchaser is unwilling to supply a copy of the invoice as a whole [section 3 (7)]. The purchaser has therefore been empowered to omit from the copy all details which would disclose the name or identity of the seller.

* These Regulations have been printed in the form of a Leaflet (No. 18), which may be obtained free of charge on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, S.W.

It will be noted that Regulation 6 (*b*) (ix) provides that if on the delivery of a consignment of a feeding stuff any portion is found to be unsuitable for feeding purposes, an estimate of the proportion of the unsuitable portion is to be made by the person taking the sample, and communicated by him to the analyst.

Where Regulation 6 applies, that is, where the sample is required to be taken in strict accordance with the Regulations, the person taking the sample is to give to the seller three days' notice in writing of his intention to take it, in order that the seller may arrange to be present if he so desires.

The Regulations include the provision in the Regulations of 1897 for the appointment of an agent by the purchaser to act on his behalf for the purpose of obtaining an official analysis.

General Regulations.—These Regulations prescribe the forms of certificates of analysis and the reports to be made by the agricultural analysts. They also prescribe the strength of the citric acid solution with reference to which invoices of basic slag or basic superphosphate are in certain cases to be construed.

Limits of Error Regulations.—These Regulations deal with the limits within which the statements made in an invoice as to certain constituents are to operate as a warranty under section 1, sub-sections (1) and (2), of the Act, in the case of fertilisers and feeding stuffs as therein defined.

4, Whitehall Place, London, S.W.,
July, 1907.

(*This Leaflet is no longer issued separately.*)

BOARD OF AGRICULTURE AND FISHERIES.

Agricultural Education in England and Wales.

Within the last twenty years there has been a great extension in the facilities for agricultural education in England and Wales, and at the present time the colleges, schools, and courses of lectures which afford opportunities to the farming community for obtaining scientific and technical instruction are numerous and well adapted to modern requirements.

The need for an efficient system of agricultural instruction began to be generally recognized in 1887, and the Departmental Committee appointed to enquire into the subject reported that "there is clear proof of great loss to the country through a want of a widespread knowledge of the most effective modes of dairy practice and of certain other agricultural operations." At that time the provision for agricultural education of any sort was extremely scanty, and the independent colleges at Cirencester, Downton, Aspatria, and Hollesley Bay seem to have been the only centres at which general instruction in agriculture was given in England, and none of these were of a type altogether suitable for the ordinary tenant farmer.

Grants for Agricultural Education.—The immediate result of the Committee's report was that in 1888 Parliament voted a sum of £5,000 to be distributed in the form of direct grants to Agricultural and Dairy Schools, and for assistance in agricultural experiments. Before the stimulus thus afforded had time to take much effect, the passing of the Local Taxation (Customs and Excise) Act of 1890 introduced a new and most important factor into the question of providing agricultural education by placing at the direct disposal of County Councils large sums of money for technical instruction. The result of this Act was that a considerable sum of money, amounting in recent years to £80,000 or £90,000 annually, has been expended by local authorities in aid of agricultural education. (It may be mentioned that the University College of North Wales, Bangor, took the lead as the first centre for agricultural instruction, and had laid down a scheme before the Act of 1890 was passed.)

Under these new conditions, the Board took the view that all the cost of instruction of a purely local character might fitly fall upon the local authorities. They decided to concentrate their much more limited funds on the development of institutions of a more or less central character, through whose machinery a great deal, if not all, of such local work could be carried on under proper and skilled supervision, and whose work and influence need not be confined to a single county.

Another object the Board had in view in assisting institutions of this class was the provision and maintenance of facilities for enabling the rising generation of agriculturists to obtain a thorough training in the science of their business. Concurrently with this object, the Board also desired to provide opportunities for farmers to obtain advice on all technical matters affecting their calling, while another and not less important purpose was the training of teachers and lecturers to meet the demand created by the extension of local instruction.

For many years the bulk of the Board's funds has been devoted to assisting educational institutions working for groups of counties, many of them of the type of a University College, but recently grants have also been given to certain other centres acting in a more restricted area. The total amount of the grants thus distributed in 1905–6 was £10,550, while in 1906–7 it was £11,550.

Institutions receiving Grants.

There are now nineteen institutions receiving grants from the Board. Nine of these are collegiate centres, each of which receives a grant from, and acts in connection with, several County Councils.

The remaining ten institutions differ somewhat in type, either from the fact that they are supported by one County Council, or are devoted to some special object such as dairying, or are farm schools like those at Basing and Penrith.

In the following list they are arranged roughly in districts with the counties with which they are connected :—

	Counties with which the Institutions act.
North of England and North Wales.	
1. Armstrong College, Newcastle-upon-Tyne.	Northumberland, Durham, Cumberland, and Westmorland.
2. Cumberland and Westmorland Farm School, Newton Rigg, Penrith.	Cumberland and Westmorland.
3. The University of Leeds.	The Three Ridings of Yorkshire.
4. The Harris Institute, Preston.	Lancashire.
5. College of Agriculture and Horticulture, Holmes Chapel.	Cheshire.
6. University College of North Wales, Bangor.	Anglesey, Carnarvon, Flint, Denbigh, and (part of) Montgomery.
Midland Counties and South Wales.	
7. Midland Agricultural and Dairy College, Kingston, Derby.	Nottingham, Leicester, Derby, and Lincoln (Lindsey).
8. Harper-Adams Agricultural College, Newport, Salop.	Shropshire and Stafford.
9. University College of Wales, Aberystwyth.	Cardigan, Carmarthen, Brecon, Pembroke, Merioneth, Radnor, and (part of) Montgomery.
Eastern Counties.	
10. Cambridge University.	Bedford, Cambridge, Essex, Hertford Huntingdon, Isle of Ely, Norfolk, Northampton, East and West Suffolk.
11. Eastern Counties Dairy Institute, Ipswich.	Counties in East Anglia.
12. Essex County Technical Laboratories, Chelmsford.	Essex, and counties in East Anglia.
13. Agricultural Institute, Ridgmont.	Bedford and adjacent counties.

Southern and South-Western Counties.	*Counties with which the Institutions act.*
14. University College, Reading.	Berks, Bucks, Dorset, Hants, and Oxford.
15. British Dairy Institute, Reading.	
16. South-Eastern Agricultural College, Wye.	Kent and Surrey.
17. Agricultural and Horticultural College, Uckfield.	East Sussex.
18. Hampshire Farm School, Basing.	Hants.
19. The National Fruit and Cider Institute, Long Ashton, Bristol.	Devon, Gloucester, Hereford, Monmouth, Somerset, and Worcester.

Looking at the map which accompanies this list (p. 4), it may be said that provision for agricultural instruction is now made to a greater or less extent over a considerable part of England and Wales. It is true that a number of counties in the centre and West of England, such as Warwick, Worcester, Hereford, and Gloucester, have not yet definitely associated themselves with any centre for agricultural instruction, except the Fruit and Cider Institute, but to a certain extent the needs of agricultural students residing in them may be met by the various adjacent centres. The south-western counties of Cornwall, Devon, and Somerset, however, lie at some distance from any recognized centre, but the needs of this district will in the near future be met by the establishment of a Collegiate Centre out of funds provided under the will of the late Mr. C. Seale-Hayne.

There is naturally a good deal of variation in the instruction given in these several institutions, and it has always been the policy of the Board to avoid any appearance of attempting to introduce rigid uniformity into the curricula, but many of the teaching courses have a sufficient resemblance to admit of a general description.

Courses in Agriculture.

Courses for Degrees.—Degrees of B.Sc. in agriculture are granted by the Universities of Wales, Leeds, Durham, and London, and students can be prepared for graduation at Bangor and Aberystwyth (University of Wales), Leeds, Newcastle (Durham University), and Wye (University of London), while at Cambridge the ordinary B.A. degree may be obtained through the medium of a "Special" Examination in Agricultural Science. In the case of the London degree residence at the Wye College is not compulsory. The courses of instruction usually extend over three years after matriculation, and include practical work. The subjects cover the whole field of agriculture, and are of an advanced scientific character.

Courses for Diplomas.—A number of institutions grant diplomas in agriculture, viz.: the Bangor, Newcastle, Aberystwyth, Reading, Wye, Midland, Holmes Chapel, Uckfield, and Harper-Adams Colleges, and the Harris Institute, Preston. These diplomas are awarded to students who have attended a somewhat shorter or less exhaustive course than that necessary for a degree, and who have passed the necessary

examinations. The courses last from two to three years, and include practical work. At Cambridge the diploma in agriculture is of a different character; it is usually taken as a post-graduate course, and, while not confined to graduates

MAP SHOWING POSITION OF EDUCATIONAL INSTITUTIONS AIDED BY THE BOARD (See list on page 2).

of the University, it is intended chiefly for students who have either taken an Honours Degree in Natural Science, or have passed the Special examination in Agricultural Science for the ordinary B.A. degree.

In most cases these courses of study also serve as a

preparation for the examination for the National Diploma in Agriculture awarded jointly by the Royal Agricultural Society and the Highland and Agricultural Society of Scotland.

At the Wye, Harper-Adams, Midland, and Uckfield Colleges, two-year "certificate" courses are also provided.

Shorter Courses.—Most of the institutions also provide instruction extending over shorter periods, suited more especially for young men, farmers' sons, and others who intend to become practical farmers, but who do not wish to take such a long course as any of the foregoing. They vary very considerably in duration, from five or six weeks to six months and over.

Instruction in Dairying.

Instruction in dairying is given at most of the Agricultural Colleges as part of the ordinary training, but dairying also forms a separate subject in which short courses of practical and theoretical instruction are given at Bangor, Newcastle, Leeds, Aberystwyth, Reading, Chelmsford, the Midland Agricultural and Dairy College, and the British and Eastern Counties Dairy Institutes.

The subject receives, however, special attention at the University College, Reading, which is in connection with the British Dairy Institute, and at the Midland Agricultural and Dairy College, Kingston, Derby. At Reading, a diploma in dairying is awarded at the end of a two years' course in scientific and practical dairying, which is designed for candidates who wish to become dairy teachers or managers of dairies. A certificate in dairying is also given after one year's study at the College and the passing of prescribed examinations, including one in practical dairy work.

At Kingston, also, similar courses are held, extending over not less than nine months.

Instruction in Horticulture.

The only College of University type in which a special course in horticulture is arranged is that at Reading. It is designed for students who intend to take up horticulture as a career. It provides training in the sciences on which the practice of horiculture is based, in market and florist work, and in fruit-growing. A diploma is awarded at the end of two years. A one year's course is also provided for those who wish to become teachers of botany and horticulture in primary and secondary schools.

Instruction in horticulture is also given at Holmes Chapel and Uckfield, where courses of two to three years are arranged, and pupils are granted certificates or diplomas.

The National Fruit and Cider Institute partakes very largely of the nature of a station for experimental research, but it is so far educational that fruit-growers and cider-makers may obtain assistance and advice bearing upon their

industry, and can visit the Institute for the purpose of seeing the methods advocated demonstrated in practice, while working pupils are received for periods of not less than one year for instruction in fruit-growing.

Courses of instruction for young gardeners in the principles and operations of horticulture, including fruit, vegetable, and flower culture, are arranged in connection with the County Technical Laboratories, Chelmsford. The complete course covers three terms of three weeks each and one term of four and a half weeks.

Instruction in Poultry-keeping.

The headquarters of instruction in this branch of farming may be said to be at Reading. A college poultry farm is maintained for purposes of practical training, and a certificate in agriculture is awarded after one year's study at the College, three months' practical training in poultry-keeping, and the passing of the prescribed examinations. Short courses are also held.

A special course in poultry-keeping is also given at Uckfield College, and at the Eastern Counties Dairy Institute, Ipswich, and certificates are awarded to successful students. Poultry-keeping, however, is a subject to which considerable attention is now given at a number of the colleges and schools.

Instruction in Forestry.

There are two centres receiving aid from the Board where definite instruction in forestry is given, viz., at Bangor and Newcastle-on-Tyne, and opportunities for instruction are also available in other directions. At Bangor a certificate in forestry is awarded to qualified students, the course covering one year.

The Senate of Cambridge University has approved of a proposal for granting a diploma in forestry, and arrangements for carrying this into effect are now in progress.

Instruction in forestry is now provided by H.M. Commissioners of Woods and Forests at the Alice Holt Woods in Hampshire and at the Forest of Dean. The University of Oxford has also taken up the subject of forestry instruction in connection with the scheme for training probationers for the Indian Forest Service at Oxford, and a diploma in forestry will be granted to members of the University who have pursued an approved course of study, and who, after undergoing a course of practical work, have satisfied the examiners in the prescribed examinations.

Notes on the Colleges and Schools.

The foregoing brief summary of the educational facilities which are now available for the present generation of agriculturists in England and Wales in the colleges and

institutions aided by the Board, refers to what may be termed their "internal" work, and does not take into account the work carried on in the various counties with which they are connected by means of lectures, travelling dairy and farriery schools, and demonstration plots, nor of the similar work done directly by County Councils.

A list of the staffs of each of the colleges and a description of the courses of instruction, the subjects taught, together with the Report of the Board's Inspector on the year's work, is given annually in the Report on the Distribution of Grants for Agricultural Education (to be obtained from Wyman & Sons, Ltd., Fetter Lane, London, E.C.), but as the circulation of this Report is more or less limited, it is thought that it may be useful to supplement the above account with a short note as to each of the colleges taken from their published reports.

1. *Armstrong College, Newcastle-upon-Tyne.*—The course for the degree of B.Sc. in agriculture (University of Durham) covers three years of three terms each, and that for the diploma three years of two winter terms only. Students can also attend for a specially arranged one-winter course in agriculture, for single terms, or for special subjects. The tuition fees vary from £10 for the winter course to £20 a year for the degree course. Students may attend any of the classes on payment of the class fees.

The Northumberland County Council Experimental Station at Cockle Park, which is worked in connection with the Department, extends to 400 acres, and affords opportunities for practical instruction and experimental research work.

In Durham the County Council have made arrangements for instruction and research in dairying to be carried out on a dairy farm of nearly 600 acres, where about 60 milch cows are kept.

For instruction in forestry, there are experimental plantations and tree nurseries at Cockle Park, while by an arrangement with H.M. Commissioners of Woods and Forests, the Chopwell Woods, which extend to about 900 acres, have been placed under the control of the College.

2. *Cumberland and Westmorland Farm School, Newton Rigg, Penrith.*—The farm at Newton Rigg comprises 116 acres of good land, three-fourths of which is grass. The primary object of the institution is to provide instruction for pupils of both sexes in the science and practice of agriculture, with special reference to dairy farming. Courses of eight weeks each for female pupils are held from March to October, and of sixteen weeks for male pupils from November to March. The fee for resident pupils from the two counties is 10*s.* a week for board and tuition.

3. *The University of Leeds.*—Students may attend a general course of instruction during the winter months, designed without reference to the requirements of any examining body. The complete course extends over three winters, but

students may take a one or a two winters' course. This leaves the spring and summer free to be devoted to practical work. The fee for the winter course is £10. There is also a summer course from April to June. In the degree course, students are required to pass the matriculation and intermediate examinations as for the ordinary science degree, and do not enter the agricultural department until they begin to work for the final examination. The latter period of study extends over two years, and the fees are about £25 a year. During these two years students are required to spend at least six months on the Manor Farm, Garforth, where each student must conduct an experiment on some agricultural subject, and present a report on the same. The farm at Garforth extends to 312 acres, and affords means of instruction in general farming, dairying, and horticulture.

4. *The Harris Institute, Preston.*—The object of the instruction given at this institute is to prepare young men and women for the work of a farmer's life by enabling them to study the principles which underlie farming operations, while the Lancashire County Council Farm at Hutton is available for practical instruction in dairy farming. The full course extends over four winter sessions of twenty-six weeks each, while there is a shorter course of two sessions.

All students from the administrative county of Lancaster receive their education free, and allowances and scholarships are also given to some in addition. The fee for external students is £10 10*s.* per session. A diploma in agriculture, as well as a certificate, is awarded, and students are also prepared for the National Diploma.

The County Farm covers 157 acres, mostly grass, and about 100 head of dairy cattle, 80 to 100 pigs, and 800 to 1,000 head of poultry are kept. Permanent dairy and poultry schools are held here, resident students from the county being received free. A diploma in dairying, a certificate in dairying, and a teacher's certificate in poultry-keeping are awarded.

5. *College of Agriculture and Horticulture, Holmes Chapel.*—This institution aims at supplying scientific and practical training in agriculture and horticulture. The complete course for the diploma covers three years, but a fourth year is necessary for obtaining a diploma with honours, for which a thesis on some original investigation carried out by the candidate must be presented. The inclusive fees for board and tuition at present are £36 per annum for those resident in the county of Chester, and £48 for those outside the county. The farm is a mixed one of about 100 acres, fairly typical of the county ; and a herd of dairy Shorthorns is kept, as well as sheep, pigs, and poultry. For instruction in horticulture there is a garden and fruit plantation, seven acres in area, and extensive ranges of greenhouses. The

farm is worked partly as an experimental station, and is utilised in that way by agriculturists in Cheshire. The College buildings have lately been largely increased by the addition of a new biological laboratory, museum, and engineering department, and a new homestead. Opportunities are thus afforded for a higher type of work on the part of students, while facilities for carrying out advisory work for farmers have been increased.

6. *University College of North Wales, Bangor.*—The College prepares students for the B.Sc. degree (three years' residence after matriculation) or for the college diploma (two years' residence), the fees for which are approximately £15 15*s.* per session and £5 for practical instruction at the farm. There is a special course of ten weeks during each of the autumn and spring terms for those who find it inconvenient to attend during the summer months, and for these courses a special fee of £5 15*s.* 6*d.* per term is charged.

The College farm is situated at Madryn, about six miles from Bangor. In area it covers 660 acres, about one-half being arable and pasture land of fair quality and the remainder an upland sheep walk. An important feature of the work at the farm is the breeding and feeding of cattle, sheep, and horses. The stock kept consists of 90 head of cattle, 1,600 sheep and lambs, and 18 horses. Students reside in the neighbourhood for part of the course.

A large number of experiments are carried out, both at the College farm and in the counties of North Wales.

The course in forestry covers three terms, and a certificate is granted. For the purpose of instruction in forestry 50 acres of hill land is being planted, and a "nursery" has also been started.

7. *Midland Agricultural and Dairy College, Kingston, Derby.*—The complete course for the diploma covers two years, but a one-year course may also be taken. Instruction in agriculture commences in October, and is divided into three terms, each of ten weeks' duration. The terms are arranged so as to occupy the time between corn harvest and hay harvest, when young men can be most easily spared from the farm. The fee for tuition is £5 per term of ten weeks to students resident in the co-operating counties, and £7 10*s.* a term for students outside that area.

The course of instruction in dairying is a thoroughly practical one, and such scientific instruction is also given as is necessary to explain the principles on which the practice depends. The teachers' diploma course requires the attendance of students for not less than nine months, and a similar course is arranged for those requiring a commercial knowledge of dairying and factory management. The fees are £6 for three months, £10 10*s.* for six months, and £13 10*s.* for nine months for county students, and double fees for

students resident outside the contributing counties. There are also six-week courses in dairying, the fee for which is similarly at the rate of 10*s.* or £1 per week.

The College is situated in the centre of its own farm of 170 acres, half of which is under permanent grass and half under arable cultivation.

8. *Harper-Adams Agricultural College, Newport, Salop.*—The diploma course extends over two or three years, and is intended for those who, having done a certain amount of pure science, are able to apply themselves to advanced work. The certificate course also takes two years, but is of a less advanced character, and is intended to provide a training in practical agriculture. The fees are £8 for tuition and about £35 for board and lodging per session of three terms.

Short courses of eight weeks are held during the autumn and spring, the fee, including board and lodging, being £10.

The farm surrounds the College and is about 235 acres in extent, and the buildings are of a very complete character. A large number of stock are fattened on the farm, and a herd of milking cows and a flock of sheep are kept. A considerable acreage is devoted to corn growing, and a large number of experiments in connection with grain and root crops, and with grass land, are carried on for the benefit of farmers, who pay periodical visits to the College farm.

9. *University College of Wales, Aberystwyth.*—The degree course extends over three academic years after matriculation, and the fees are £10 per annum for tuition. The agricultural diploma course also extends over three years, but students are required to attend during the winter and spring terms only, and to spend twenty-four weeks in each of the first two years of their course either on the College farm or on some other approved farm. The tuition fees are £7 10*s.* for the two terms and £5 for instruction on the farm for twenty-four weeks.

There are also short courses for farmers, intended to provide technical instruction for those who have already some experience of practical agriculture. Part I. extends over eight weeks, for which the fee is £3 ; Part II. lasts for twelve weeks, and the fee is £3 10*s.* ; Part III. is of a more advanced character, and extends over the winter and spring terms of the subsequent year, the fee being £7 10*s.*, with an additional charge for practical work.

Courses in dairying, qualifying for a certificate, are held in the summer, lasting eight weeks, for which a fee of £6 is charged ; the course for the College diploma in dairying extends over three terms.

The farm is about 4½ miles from Aberystwyth, and consists of about 200 acres of land, of which about 50 acres are arable. The stock kept includes Shire horses, Shorthorn, Hereford and Welsh cattle, and various breeds of sheep and pigs.

10. *Cambridge University.*—The University grants a diploma in agriculture to those candidates who pass the requisite scientific and practical examinations. The University has also instituted a special examination in agricultural science for the B.A. degree. To obtain the B.A. degree a student in agriculture must reside as a member of the University for three years (nine terms), and must pass (*a*) the Previous examination ; (*b*) the General examination or Part I. of a Tripos examination ; and (*c*) the Special examination in agricultural science. For members of the University the cost will vary from £100 to £150 a year. For students from contributing counties who do not join the University and are willing to live plainly, the cost need not exceed £60 for twenty-four weeks, including board and residence, and fees for lectures and laboratories.

The farm at Impington, about three miles from Cambridge, is 140 acres in extent, and is used for teaching purposes. Experiments on soils, manures, crops and stock of the usual kind are conducted on this farm and at a number of centres in the adjacent counties. Important researches into the breeding of plants and animals are being carried out in the University Laboratories and at the farm, and facilities for advanced work are offered to students.

11. *The Eastern Counties Dairy Institute, Ipswich.*—Instruction is afforded here in dairying and poultry-keeping. The full course extends in summer from April to October, and in winter from November to March, but students can attend for any period. The fee for a full course of instruction is at the rate of £5 per month. Practical and theoretical instruction in butter-making and soft cheese-making costs 10*s.* 6*d.* per week. Board and lodging can be obtained for 12*s.* 6*d.* a week and upwards. A poultry school, extending over a period of three weeks, is held twice annually at a fee of £3. Farms comprising 350 acres of land are also occupied, about 30 cows being kept.

12. *The Essex County Technical Laboratories, Chelmsford.*—The principle adopted at this centre is to base the teaching of the sciences fundamental to agriculture on practical laboratory work. A course of nine weeks is held in the winter months in agriculture, chemistry, physics, and biology. No instruction is given in the actual processes of farm work, it being held that these must be learnt upon the farm itself.

In dairying, the instruction is given in an elementary two-weeks' course, and a more advanced course of six weeks ; practical work in the dairy is an important feature in both courses.

In horticulture, four courses of instruction of three to four weeks each are given to young gardeners. The school garden is three acres in extent, and consists partly of botanical plots and partly of fruit, vegetable and flower borders. There are

also a number of classes in scientific subjects. County scholarships, entitling holders to free tuition, are given, no fees being charged.

13. *The Bedford Agricultural Institute, Ridgmont. Aspley Guise.*—This institute consists of a good farmhouse with class-rooms and dormitories, a small dairy, and a farm of rather over 270 acres. It is open to men in winter and women in summer, and the courses, which last for five weeks each, are designed to afford instruction on sound practical lines to young men and women who cannot take long advanced courses of training at the higher agricultural colleges. For students living in the county of Bedford the fee, including board and lodging, is £2 for the course, and for other students £10. Special arrangements, however, have been made for the admission of students from adjacent counties.

13. *The University College, Reading.*—Separate instruction at this College is given in agriculture, dairying, poultry-keeping and horticulture.

In agriculture, there are two regular courses, one in scientific and practical agriculture extending over two years for the diploma, and a six months' course for the certificate. The fee for the diploma course is £18 per session of three terms, and for the certificate course £12 for two terms. In the case of students from contributing counties, these fees are reduced to £13 10*s.* and £9 respectively.

In dairying, two regular courses are provided, one extending over two years for the diploma, and one of three terms (October to July) for the certificate. The fee per session of three terms for the diploma course is £16 (excluding practical work at the British Dairy Institute), and for the certificate £20, reduced in the case of county students to £12 and £17 respectively. There is also a short course of ten weeks in dairying, for which a fee of £10 is charged.

The instruction in poultry-keeping is given at the College Poultry Farm, where courses of five and ten weeks are held, the fee being at the rate of £1 per week. A certificate in aviculture is given to students holding the diploma or certificate in agriculture or dairying who have received theoretical and practical instruction and have passed the necessary examinations. Students can also attend at the College Poultry Farm for practical work only.

The work of the department of horticulture consists of lectures and laboratory work in the College and of practical work in the College garden. There are two principal courses of instruction, one for the diploma in horticulture extending over two years of forty weeks each, and one for the certificate extending over one year.

Excellent facilities are afforded for practical instruction in all these subjects. The College Farm at Shinfield, about two

miles from Reading, comprises about 150 acres; about $7\frac{1}{2}$ acres of this consist of copse or wood, the remainder being permanent pasture and arable land in equal proportions. Instruction is given here regularly in the afternoons, and students are encouraged to assist in the farm work. The buildings of the British Dairy Institute, which are near the College, are available for practical dairy work. The College Poultry Farm is at Theale, about five miles from Reading, and comprises about 40 acres, mostly meadow land. A large stock of poultry is kept and all modern appliances connected with both natural and artificial methods of hatching, rearing, feeding and fattening are provided. The College garden for instruction in horticulture is 4 acres in extent and consists of fruit plantation, vegetable and flower gardens, botanic garden, and shrubbery. There are good buildings, a large number of pits and frames, and 13 glass houses. In addition, 12 acres of land at the College Farm have been set apart for fruit growing.

15. *The British Dairy Institute, Reading.*—The British Dairy Institute is under the management of a committee representing the British Dairy Farmers' Association and the Reading College. It contains large milk-receiving, butter-making, and milk-testing rooms, four cheese-making rooms, and seven rooms for ripening cheese. It is equipped with the best modern apparatus for the manufacture of dairy produce. The instruction given is both practical and theoretical, and is arranged to suit the requirements of those who need either elementary or advanced dairy instruction. The fees for all subjects are £1 per week, £10 for three months, £18 for six months. Practical and theoretical instruction in buttermaking only costs 10*s.* per week. The prospectus of the British Dairy Institute will shortly be revised, and it is proposed to announce a summer course of six months (fee £18) from March to September. There will also be two courses of three months each, the fee being £10 for each course.

16. *South-Eastern Agricultural College, Wye, Kent.*—The agricultural instruction at this College is arranged in three courses:—(1) The London University B.Sc. course extending over four years; (2) the diploma course, extending over three years; and (3) the certificate course of two years. The mornings are allotted to lectures and laboratory work, and the afternoons are occupied by various practical classes on the farm, the fruit and hop plantations, the dairy, poultry-yard, &c. Lectures are given in the evening.

The inclusive fee for board and tuition is £120 a year; for tuition only, £60 a year; and for a limited number of students resident in Kent and Surrey £60 a year, including board and lodging, or, for tuition only, £15 per annum. Special terms are also given to residents in the parish of Wye. Several scholarships are awarded.

The College Farm consists of about 460 acres, of which 176 are arable and the remainder pasture, gardens, buildings, &c. The sheep kept are chiefly pure-bred Romney Marsh and Southdowns, and there is a herd of pedigree Lincoln Red Shorthorns, as well as Aberdeen-Angus, Ayrshires, Jerseys and Guernseys. A hop garden has been laid out, showing different systems of training hops. Fruit-growing receives special attention, and about 7½ acres have been planted within the last few years. Horticultural instruction is also given, some 7 acres being devoted to vegetable and flower growing, and a range of three glass houses to hot-house work. A series of demonstration plantations and a nursery for forest trees are being established to enable practical instruction in forestry to be given.

17. *Agricultural and Horticultural College, Uckfield, Sussex.*—The courses of instruction here comprise (1) a two years' course qualifying for the College certificate, (2) a twelve weeks' course for farmers' sons during winter, and (3) a course for land agency students from October to March. The fees for students from the county of East Sussex are £16 13*s.* 4*d.* per term, but £25 for students outside the county, including board, lodging and tuition. The fees for non-resident students are £10 10*s.* per term. The farm comprises 101 acres, about equally divided between pasture and arable. A herd of Shorthorns is kept, as well as sheep, pigs and poultry. Bullocks are fattened during the winter.

There is a garden of nearly five acres, of which three acres are planted with fruit and the remainder with vegetables. Special attention is given to horticulture and poultry farming.

18. *The Hampshire Farm School, Basing.*—At this school provision is made for training lads or young men in winter and women in summer. The winter course lasts for twenty-four weeks and is thoroughly practical. Indoor instruction for about one hour is given each morning and afternoon. As regards outdoor work, the lads are divided into four groups, each taking a month at farm work, in the dairy, with the poultry, and in the garden. Once a week they are taken to Basingstoke market. The summer course is designed mainly for women and is divided into three periods of five weeks each. It is largely devoted to dairying. The fees for pupils from Hampshire are 10*s.* per week for those connected with dairy work or farming, and 15*s.* for other Hampshire pupils, including board, lodging and tuition. All other pupils £1 5*s.* per week. The farm consists of 71 acres, 31 acres being dry pasture, 15 acres water meadow, and the remainder arable. There is also a specially built dairy and a garden of about 1½ acres.

19. *National Fruit and Cider Institute.*—The Institute is situated at Long Ashton, near Bristol, and occupies some 15 acres of land. About two-thirds of the area is occupied

by orchards, about one acre is used as a nursery, and two acres as a fruit plantation. Students are received for scientific instruction in the laboratory at a charge of four guineas for one month's instruction and ten guineas for three months. Working pupils from subscribing counties can be received at the Institute for a period of not less than one year for instruction in fruit-growing. Such pupils will receive 7*s.* 6*d.* per week.

All the above institutions receive grants from the Board, and are also supported by their respective County Councils. With reference to the fees which are mentioned, it must be remembered that advantages are usually given to students from contributing counties, frequently in the form of reduced fees, and also by means of scholarships.

Notes on other Institutions.

In order to make this account of the facilities for agricultural education in England complete, reference must also be made to several other institutes of a semi-public character which do not receive grants from the Board, and also to the local work of the County Councils.

Among the institutions not receiving grants from the Board may be mentioned :—

The Royal Agricultural College, Cirencester.— This institution was founded by Royal Charter in 1845, and is intended to provide a course of instruction, both scientific and practical, suitable for agriculturists, landowners, land agents, &c. It possesses a farm of 500 acres, and its prize live stock are well known. An area of 3,000 acres of woods, the property of Lord Bathurst, is available for instruction in forestry. The entire course covers two years (six or seven terms), but there is a special one-year course. The fees for in-students are £45 per term of about eleven weeks, and for out-students £25 per term for tuition only.

The Agricultural College, Aspatria.—The course covers two years, and forms a suitable preparation for the National Diploma in agriculture and similar examinations. Arrangements are made with farmers in the vicinity for practical work. The fees are £31 10*s.* per term of twelve weeks, including board, lodging, and tuition.

The Horticultural College, Swanley, Kent.—This College aims chiefly at giving a thoroughly systematic training to women who wish to become market-growers and gardeners, or teachers, lecturers, &c. The full diploma course extends over two to three years. The fees are from £80 a year of about 39 weeks, including board, lodging, and tuition, or £40 a year for tuition only. The College stands in 43 acres of land, divided into 2 acres of flower garden, 12 of kitchen and market garden, and 17 of fruit plantation, the remainder being meadow, &c. There are 21 large glass houses and conservatories.

There are also certain private institutions giving instruction in agriculture, dairying, &c., such as the Lady Warwick College, Studley Castle, Warwick, as well as several secondary schools, such as the Shepton Mallet Grammar School, the Brewood Grammar School, the Cambridge and County School, and the Dauntsey Agricultural School, to which reference is made below.

Notes on County Work.

Most of the counties of England and Wales provide agricultural education in one form or another out of the funds provided by the Local Taxation (Customs and Excise) Act, 1890. In some cases the work is carried on by the county through a permanent official staff of instructors, and in others through one of the colleges to whose funds it contributes.

In addition to the colleges and farm schools to which reference has already been made there are several local institutions of a somewhat analogous character, which are maintained by certain counties for instruction in agriculture, dairying, &c.

1. *The County Council Farm, Hutton, Lancs.*—This farm, which has already been referred to in connection with the Harris Institute, is maintained as a fixed dairy and poultry school, and is situated about three miles from Preston. Five junior courses lasting eight weeks each, and one advanced course lasting twelve weeks are held each year, and in addition one course is held for students taking the examination for the National Diploma in dairying. Eight and twelve-week courses in poultry-keeping are also held.

2. *Worleston Dairy Institute, Cheshire.*—This is a permanent dairy school maintained by the County, at which three courses are held annually, each of fifteen weeks' duration.

3. *Lleweni Hall Dairy School, Denbigh.*—This school is maintained by the counties of Flint and Denbigh in conjunction with the University College at Bangor. The school is open for private pupils all the year round and courses of six weeks' duration are held from time to time.

4. *The Dairy School, Garforth, Leeds.*—This is maintained by the three Ridings of Yorkshire on the farm which is worked in connection with the University of Leeds. Three courses of six weeks' duration are usually held during the summer and poultry lectures are also given.

5. *Fixed Dairy School, Monmouth.*—A fixed dairy school is arranged for at a farm in a different part of the county each year, and pupils are taught the principles of cheese-making and dairy management.

6. *Dairy School, Warwick.*—A fixed school is maintained by the county during the summer season, at which three courses of eight weeks each were held in 1906.

7. *Fixed Cheese School, Somerset.*—A cheese school, maintained by the county, is held on a different farm each year from April to October. Pupils are taken for any period, the full course being four weeks.

8. *Gloucester Fixed Dairy School.*—A fixed dairy school is maintained throughout the year. Short courses are held, and they are arranged to extend over a longer or shorter period according to the number of days pupils can attend.

9. *The Dauntsey Agricultural School, West Lavington, Wilts.*—This endowed school is carried on under a scheme approved by the Charity Commissioners as a secondary school, and the ages of the students are thirteen to nineteen years. In addition to the usual subjects included in a commercial education, instruction both theoretical and practical is given in all branches of knowledge pertaining to farming. The school stands in about 15 acres of land, two to three acres of which are devoted to fruit and vegetable culture. The fees are £6 per annum for day boys, and, for boarders, £30 for foundation boys and £40 for other boys.

County Lectures and other Methods of Instruction.—With regard to the general county work, it may be said that lectures and instruction in agriculture, dairying, poultry-keeping, bee-keeping, farm hygiene, farriery, manual processes, and horticulture are given in a large number of counties.

The instruction in dairying may be given at a fixed dairy school, or by means of a migratory dairy school, which visits a number of different centres each season. A similar system is adopted with farriery.

A number of counties carry out field experiments or demonstrations, and many have school gardens attached to day or evening schools. In the same way many have fruit-growing stations, demonstration gardens, or trial allotments.

Full information respecting the work carried on in each county will be found in the Board's Annual Reports on Agricultural Education, referred to on p. 7.

NOTE.—A large number of the agricultural colleges carry out tests of farmers' milk at a fee of 6*d.* per sample. An account of these Tests for Farmers' Milk will be found in Leaflet No. 146.

4, Whitehall Place, London, S.W.,
October, 1907

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

Leaflet No. 198.

BOARD OF AGRICULTURE AND FISHERIES.

Rearing and Marketing of Geese.

It may be said that under suitable conditions, and in comparatively small flocks, geese are as profitable as any other class of poultry. They are essentially suitable stock for farmers and commoners, for, being grazers, they require a larger range than other poultry-keepers have available; but it is chiefly owing to their grazing habit that so many farmers will have nothing to do with them. The objections usually advanced are that four-legged stock will not graze after them, and that they are destructive to the herbage of the pasture. These objections, however, do not appear to be well-founded. Horses, cattle, and sheep have all been found to graze freely after geese, but owing to the semi-liquid excreta of the latter it would be well to allow the pasture a few days in which to freshen after the poultry have been removed. A few hours rain will wash the excreta into the soil. There are many open land districts where geese might be reared in considerable numbers without fear of injury to the pastures.

With regard to the supposed destruction of herbage, geese will search for and greedily devour the root of the buttercup, thus consuming a weed which is undesirable for other stock. This habit should commend geese to dairy farmers, in whose pastures the acrid weed mentioned is frequently unduly abundant.

The Demand for Geese.

It is not generally wise or desirable to run geese in any but small flocks, except in special circumstances, the ordinary demand being limited and variable. In many, perhaps most, localities a moderate supply will nearly always find a remunerative sale as goslings; or the birds may, without undue risk, be sent off the grass to London during the season. The distinctive goose market at Michaelmas has practically ceased to exist; there is still a demand at that time of year, but not materially greater than that which now prevails during earlier months. Where stubbles are available some of the birds may be profitably run on them for the autumn markets, or fattened later for Christmas, when there is a more or less considerable demand for fat geese. At the latter season, however, the goose occupies a second place to the turkey; moreover, the position of the English

goose at Christmas is further assailed by the imported goose, many poulterers regularly stocking foreign birds to the entire exclusion of English, on account of the more favourable wholesale price. Unless, therefore, the English producer can market birds of exceptional quality, he will find the average Christmas market unsatisfactory, and would perhaps do better to dispose of his goslings off the grass in May and June. If sent to London salesmen the consignments should be timed to reach the markets on Wednesdays or Fridays, these being the most suitable days for favourable sales.

A complaint often made against the goose is that it is too large for ordinary households. In southern Europe what is known as the Roman Goose is chiefly kept, producing in September and October fine fleshed birds weighing 8 to 10 lb. each. If these were introduced a demand would doubtless arise much greater than exists at present.

Breeds.

For the English farmer, or commoner, the best breeds for purely table purposes are the Embden and the Toulouse, or a cross between the two.

The Embden has white plumage, flesh-coloured bill, orange shanks, a square, deep-set body, and a tall upstanding carriage. The average weight for an adult gander is 20 lb., and for a goose 18 lb., but much greater weights are attained.

The Toulouse is of a dark grey colour on the upper part and a lighter shade on the breast, which gradually merges into the white of the under part; the bill is of a red flesh colour and the legs orange-red; the body is full and compact, with a convex back. The weight is generally greater than that of the Embden.

The Canada Goose, which is extensively bred in America, thrives better than the Embden or Toulouse on marshy land; it is more delicate in flavour than the other breeds, and is consequently preferred by many on that account. Its colouring of brown-grey, white and black, being very effective, it is in demand—to a limited extent—for the stocking of ornamental waters.

The Roman Goose referred to above is very precocious, rapid in growth, and an excellent layer. It carries a large quantity of excellent meat in relation to its size, which is small—perhaps 12 lb. to 14 lb. when fully grown.

Breeding.

Geese will continue to produce eggs profitably until an advanced age, and instances are known of geese nineteen years old which still continued to lay an average of fifty-five eggs each per year. For hatching purposes the eggs of

mature birds are much more reliable than those of young stock : the risk of infertility is reduced, and the vigour and hardiness of the goslings increased. Rearing therefore being easier the profit is more assured. The breeding pen should consist of a gander and two or three geese ; the geese will commence to lay in February or not later than early March, producing (if not permitted to sit) an average of from fifty to sixty eggs in a season. An ordinary hen will cover four or five goose eggs, ten being a suitable number for a goose ; the period of incubation is thirty days. The stock birds may be housed in a roomy shed, well littered, and having a wire-netted open front ; when the laying season approaches a rough nest should be made in a convenient place, and provided with an ordinary nest egg. If this is not done the eggs may be dropped near the water, to which it is necessary that the geese should have access not only for swimming but also to ensure fertility in the eggs. Stock birds should usually have a small allowance of soft food in the early morning, and a little corn when they return from the fields at night.

Rearing and Fattening.

When hatched the goslings should be cooped out with the hens that have hatched them, in the same manner as chickens, and during the first week or two they should be fed frequently. For the first few days they may be fed on biscuit meal (or soaked bread), mixed with a good proportion of well-chopped dandelion leaves. This may be changed to Sussex ground oats* and boiled rice at the third or fourth day. By the end of the first week they will have made considerable progress as grazers, and their rations will consequently not require increasing in the same proportion as those of other growing stock. At present prices it is essential that the breeder of geese should depend chiefly on natural food, or the cost of rearing and fattening may be greater than the return.

By about the tenth day they will be able to do without any brooding, and the hens may be turned out and brought into condition for laying again. On a suitable grass range the goslings will then make rapid progress with a comparatively small allowance of bought food.

Early Marketing.—When goslings are reared for early marketing their grass range should not be too extended, and they should not be allowed to enter swimming water ; in addition to the grass, the food should consist of two moderate meals daily of a soft mixture, in the making of which barley meal, middlings, and a small proportion of

* This poultry food is made by grinding oats into a fine meal. The special finely ground product required is obtained by mixing a small proportion of barley with hard flinty oats. Russian and other foreign oats are usually employed in preference to the softer home-grown grain.

brewer's grains may be used. Goslings thus treated should be in good killing condition before they are three months old.

Autumn Marketing.—Goslings intended for the autumn market should be run free during the earlier months, or may, during part of the time, be folded on turnips, being more closely confined for the last month before killing and fed on meal and brewers' grains, with one feed per day of steeped oats.

Marketing in Winter.—When kept for winter fattening goslings should, from the time they are feathered, be allowed the same liberty and be treated in the same manner as old birds, being confined to a roomy open-fronted shed for a month or five weeks before killing, and allowed two full meals daily. The meals should consist of soft food in the morning and corn in the afternoon—the grain being fed in the water troughs with a good supply of grit. It is also necessary to keep the fattening birds well supplied with green food during the period of their confinement.

Killing and Preparing.

The birds should be sufficiently fasted before killing. Dislocation of the neck is, perhaps, the best method of killing, as it has the great advantage of being cleanly, but in the case of large birds, or where there is a doubt as to the strength of the wrist, it should not be attempted. The alternative method is (1) to pinion or lock the wings over the back to prevent unnecessary struggling, (2) to tie the legs and hang the bird up by them, (3) to stun the bird by a sharp blow on the back of the head, and (4) immediately to sever the jugular vein by means of a sharp penknife thrust through the neck behind the lower jaw. The usual preparation for shop or market consists in rough plucking and pressing until cold. A Leaflet (No. 201) on The Marketing of Poultry has been issued, and contains information on the various markets throughout the country.

4, Whitehall Place, London, S.W.,
September, 1907.
Revised, February, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

A pamphlet containing 16 leaflets dealing with Poultry and Bees, their Breeding and Management, may be obtained from the same address, price 1d. post free.

Leaflet No. 199.

BOARD OF AGRICULTURE AND FISHERIES.

A Pine Disease (*Diplodia pinea*, Kickx.).

Diseased shoots of pine have been sent to Kew for investigation on several occasions, and from widely separated districts during past years; but until March, 1906, no definite statement could be given as to the primary cause of the disease, owing to the unsuitable condition of the earlier specimens received. The reasons for this will be obvious, when the development of the fungus causing the injury is explained.

Description and Life History.

The disease is confined to terminal shoots, and is recognised by the yellowing and subsequent shedding of the leaves, followed by the death of the shoot, which dies back for a distance of 6 to 10 ins. These dead shoots are persistent, and, commencing with the year following infection, furnish a crop of fungus spores each season, which in turn, infect toher shoots.

Diplodia pinea, Kickx., the fungus causing the injury, is a wound parasite, that is, its spores on germination cannot enter through an unbroken surface into the living tissues of its host-plant, but only through a wound made by some otner agent. In every diseased shoot examined the presence of one or more slight wounds penetrating the cortex is indicated by a slight incrustation of resin surrounding the injured spot. It is through these injured points that the fungus gains an entrance into the living tissues. When once established, the mycelium extends rapidly towards the tip of the shoot, soon choking up the vessels and arresting the food supply intended for the growing point of the shoot. The mycelium of the fungus does not extend in the shoot for more than one or two inches below the point of infection, and the length of a dead shoot consequently depends on the distance of the wound below the apex of the shoot.

Experiments conducted at Kew show that, within two months after infection, the leaves become yellow and begin to twist. This is due to desiccation, and at the expiration of four months all the leaves have fallen, and the shoot is dead.

Shoot of Weymouth Pine (*Pinus Strobus*), killed by *Diplodia pinea*, Kickx.

In many other species of *Diplodia* fruit is not produced on the host-plant until the year following infection, and this condition of things appears to prevail in the fungus under consideration. The fruit condition is indicated by the presence of numerous blackish warts protruding through minute cracks in the dead bark.

Three-year-old plants of Weymouth pine (*Pinus Strobus*, L.), Scots pine (*Pinus sylvestris*, L.), Spruce (*Picea excelsa*, L.), Silver Fir (*Abies pectinata*, DC.) and Larch (*Larix europaea* DC.) were infected. Spores obtained from material supplied by Professor Somerville were used, these spores having been found to be in a condition capable of vigorous germination when placed under favourable conditions.

Spores placed on the unbroken surface of young shoots failed in every instance to infect the plant, whereas spores placed on the drop of moisture extending from a minute puncture in the bark invariably set up infection, which resulted in the formation of a dense growth of mycelium in the tissues, followed by a yellowing and falling of the leaves, as stated above.

Positive results were obtained in the case of the two species of *Pinus* named above. No infection occurred on species of *Picea*, *Abies* or *Larix*.

Although the fungus undoubtedly kills the twigs it infects, yet its entry depends on the presence of some previous wound, which, in all the specimens examined, was very small, and of the same general appearance, and was, in all probability, caused by one particular kind of insect. It is important that this point should be settled.

Prevention.

In the case of nursery stock and young trees, the removal of all dead shoots would do much towards checking the spread of the disease, as the fungus is not known to occur on other kinds of trees.

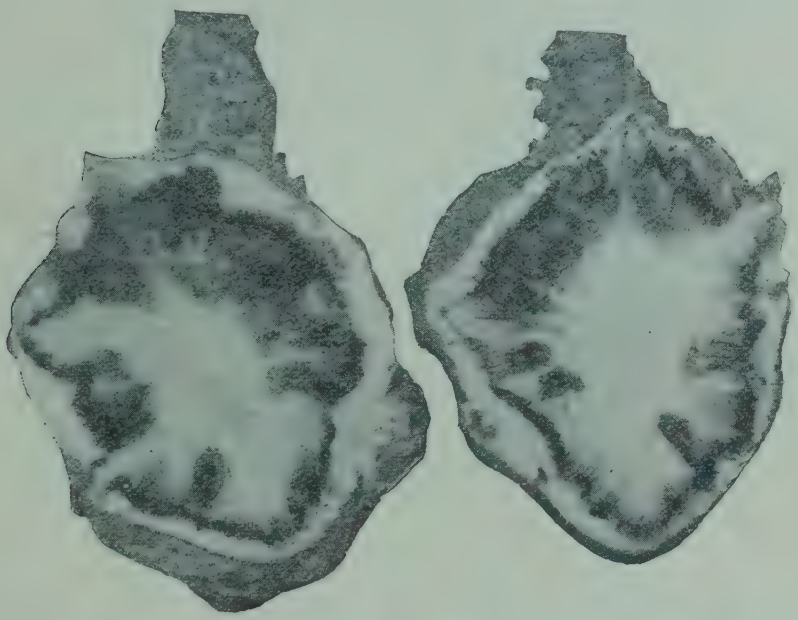
4, Whitehall Place, London, S.W.,
November, 1907.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Black Rot of Cabbages, Turnips, &c.

(*Pseudomonas campestris*, E. Smith.)



Cross Section of Cabbage Stem, Shewing Blackened Vascular Bundles.

This disease is very prevalent in the United States, and during recent years has occurred in various European countries. It is of bacterial origin and causes the plant to rot and form a pulpy fœtid-smelling mass. Cauliflowers, cabbages, Brussels sprouts, radishes, white and swede turnips, in fact all cultivated plants belonging to the Crucifer family, are attacked.

In this country rape appears to be most susceptible to the disease. In an extensive trial plot of various kinds of cabbages, savoys, Brussels sprouts, &c., those that contained rape "blood" were first attacked, whereas those strains without a taint of rape were the last to succumb.

Description and Life History.

The lower leaves are usually infected first, the germs entering the substance of the leaf through minute openings (water stomata) situated along the margin, or through wounds caused by the punctures of insects, &c. In cases where the soil is infected the germs may gain an entrance to the plant through broken roots at the time of transplanting. When the bacteria are once inside the leaf they multiply rapidly and are confined to the veins, from whence they pass down the leaf-stalk into the stem. From the stem they quickly pass into the stalks of other leaves, so that within a

short time every leaf is infected. As the bacteria travel along the veins and the vascular bundles of the leaf-stalks and stem a dark-brown or blackish substance is deposited, which causes the veins to show up as a black network; the vascular bundles of the leaf-stalk and the stem also appear as black points or a blackened ring when cut across. The presence of this blackening of the veins is a certain indication of the presence of the disease.

How the Disease is Spread.

a.—As stated above the germs may enter the plant through water stomata, wounds, broken roots, &c.

b.—The soil may be infected by diseased plants which have been fed to cattle, pigs, &c., or which have been otherwise transferred to the fields.

c.—It has also been proved that the germs are conveyed from diseased to healthy plants by insects.

d.—It has been considered by growers that the disease can be transmitted by means of the seed, and this idea has been proved to be correct by Harding, Steward and Prucha, who have shown that, in the United States, much of the cabbage seed offered for sale is contaminated with the germs of black rot disease.

Prevention and Remedy.

1.—Transplanting should be carefully done, so that the roots are injured as little as possible.

2.—Infected plants should neither be buried nor used as food for cattle or pigs, but should be promptly removed and burned, or infection of the land will follow sooner or later.

3.—Rotation of crops is advisable, cereals, potatoes, and legumes not being attacked.

4.—The following precautionary measure may also be suggested. Seed can be disinfected before sowing by soaking it for 15 minutes in a solution consisting of one part of corrosive sublimate in 1,000 parts of water, or in a solution of 1 lb. of formalin in 30 gallons of water. It is hardly to be expected that this treatment will prevent either leaf or root infection in infected soils, but it may be safely relied upon to prevent all danger from infected seed. It will not injure the germinating power of the seed.

4, Whitehall Place, London, S.W.,
August, 1907.

The Board of Agriculture and Fisheries would be glad if recipients of this leaflet would make it known to others interested in the subject. Copies may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place London, S.W. Letters of application so addressed need not be stamped.

GENERAL INDEX.

Figures in large type (*e.g.* **126**) *indicate the number of the Leaflet, and those in small type* (*e.g.* 2) *the page of the Leaflet. Generic and specific names are given in italics. Insecticides, fungicides, &c., are given in a separate index.*

Abortion in cattle, **108.**
Act, Chaff-Cutting Machines (Accidents), 1897, **177,** 1.
— Dogs, 1906, **190.**
— Dogs, 1871, **190,** 1.
— Fertilisers and Feeding Stuffs, 1906, **196.**
— Industrial and Provident Societies, 1893, **111,** 2.
— Land Drainage, 1847, **181,** 1.
— Local Taxation (Customs and Excise), 1890, **197,** 1.
— Railway and Canal Traffic, 1854, **110,** 1.
— Railway Rates and Charges Order Confirmation Acts, 1891-92, **110,** 2.
— Threshing Machines, 1878, **177,** 1.
Agaricus melleus, **174,** 1.
Agricultural Organisation Society —address of, **111,** 2.
Alsike, **184,** 8.
American gooseberry mildew, **195.**
Anconas, **129,** 2. 6, 7.
Annual sow thistle, **166,** 9, 12.
Aphides, **104.**
Aphis, larch, **155,** 1, 3.
Aphis rumicis, **104,** 2.
Apple culture, **134.**
— scab, **131.**
Apples—packing and grading of, **134,** 7.
— manuring of, **106,** 7.
— storing, **134,** 8.
— types of trees and varieties, **134,** 3, 4.
Armillaria mellea, **174.**
Artichokes, manuring of, **106,** 6.
Artificial manures—for market garden crops, **106.**
Asparagus, manuring of, **106,** 5.
Asparagus fly, **124.**
Aspidiotus Ostreæformis, **107,** 4.
Aylesbury ducks, **167,** 2.

Bacillus phytophthorus, **117.**
Bacterial disease of tomatoes, **152.**
Banded pine weevil, **138.**
Barbary ducks, **167,** 5.
Bare fallows, **172.**
Barley, blindness in, **159.**
— threshing of, **149.**
Basic slag, **170,** 4, 5.
Bean aphis, **104,** 2.
Bean beetle, **150,** 2.
Bean pod canker, **185.**
Beans, dwarf French, manuring of, **106,** 5.
Beech, as a hedge plant, **147,** 7.
Beech coccus, felted, **140.**
Bee-keeping—advice to beginners in, **128.**
— address, British Bee-keepers' Association, **128,** 4.
— appliances used in, **128,** 1.
— hives, **128,** 2.
— honey, **141.**
Bees—diseases of, **128,** 4.
Beet, heart rot of, **144.**
Beetroot, manuring of, **106,** 4.
Beta vulgaris, **169.**
Big joint of lambs, **130.**
Bindweed, **112,** 1, 3.
Birds, as destroyers of insects, &c. **103,** 4; **107,** 4; **123,** 3; **132,** 5; **186,** 7.
Blackbird—enemy of slugs, **132,** 5.
Black leg—of cattle and sheep, **102.**
— — of potatoes, **117.**
Black rot of cabbages, turnips, &c., **200.**
— scab of potatoes, **105.**
— stripe of tomatoes, **164.**
Blindness in barley and oats, **159.**
Brahmas, **114,** 7; **129,** 6; **176,** 2.
Brie cheese, **179,** 8.
British Bee-keepers' Association—address of, **128,** 4.
Broccoli, manuring of, **106,** 2.
Bruchus pisi, **150.**
— *rufimanus*, **150,** 2.
Brussels sprouts, manuring of, **106,** 2.
Bulb mite, **136.**
Butter, points in judging, **192,** 9.
— potting, preserving, &c., **192,** 8.
— ratio, **192,** 1.
Butter-making, importance of cleanliness in, **151,** 7.

Butter-making on the farm, **192.**
— utensils, **192,** 3.
Buttercups, **112,** 4.

Cabbage moth, **109.**
— root fly, **122.**
Cabbages—black rot of, **200.**
— manuring of, **106,** 2.
— white rust of, **163.**
Caecilius flavidus, **155,** 1.
Cakes, damaged — as a manure, **175,** 5.
Calf rearing, **142.**
— cost of, **142,** 6.
— cream substitutes for **142,** 3-4.
— milk substitutes for, **142,** 6.
Calliphora—maggot flies, **126.**
Calves, prevention of white scour in, **101.**
Camembert cheese, **179,** 4.
Campines, **129,** 6.
Canada goose, **198,** 2.
Carduus crispus, **166,** 4.
Carriage of goods by rail at owner's risk rates, **110.**
Carrots, manuring of, **106,** 3.
Cattle—abortion, **108.**
— black leg or quarter ill, **102.**
— calf rearing, **142.**
— mange, **135.**
— suitable dairy breeds, **187.**
— white scour in calves, **101.**
Cauliflowers, manuring of, **106,** 2.
Cayuga ducks, **167,** 5.
Cecidomyia destructor, **125.**
— *heterobia*, **165,** 4.
— *marginem-torquens*, **165,** 4.
— *rosaria*, **165,** 3.
— *saliciperda*, **165,** 1.
— *salicis*, **165,** 3.
— *terminalis*, **165,** 3.
Celery, manuring of, **106,** 6.
Centrifugal honey extractor, **128,** 1 ; **141,** 3.
Chaff-Cutting Machines(Accidents) Act, 1897, **177,** 1.
Chalcididæ, **104,** 4 ; **107,** 4.
"Chalk" thistle, **166,** 9, 11.
Charlock, **112,** 1, 3, 4.
Cheese—making of soft and cream cheeses, **179.**
Cheese-making, importance of cleanliness in, **151,** 7.
Chermes laricis, **155,** 1.
Cherries—useful varieties, **148,** 5.
Chickens—cost of hatching, **129,** 2.
— day old, **157.**
— dry feeding of, **114,** 2.
— feeding of, **114,** 2.
— hatching of, **129,** 2.
— prices for day old, **157,** 2.
— rations for, **114,** 2-5.
Chickens—wet mash feeding, **114,** 3.
"Chilled Brood" of bees, **128,** 4.
Chinese goose, **198,** 2.
Chrysophlyctis endobiotica, **105.**
Churning of cream, **192,** 5.
Cleanliness in the dairy, **151 ; 187,** 4.
Cleansing of water courses, **181.**
Cleavers, **112,** 1.
Clover, alsike, **184,** 8.
— crimson, **182.**
— red, **184.**
— sickness, **184,** 1.
— white, **184,** 4.
Cnicus arvensis, **166,** 5.
— *lanceolatus*, **166,** 1.
— *palustris*, **166,** 5.
Coccinellidæ, **104,** 4.
Cochins, **114,** 7 ; **129,** 6.
Cockle, **112,** 1.
Cod liver oil for calf rearing, **101,** 2 ; **142,** 4.
Coenurus cerebralis, **119.**
Collar rot of trees, **174.**
Colleges and schools, **197,** 2.
— — notes on, **197,** 6-17.
Coltsfoot, **194.**
Coniothyrium diplodiella, **158.**
Construction of pigsties, **121.**
Co-operative Egg and Poultry Societies, **111.**
Coral-spot disease, **115.**
Corky scab of potatoes, **137,** 1.
Corn marigold, **112,** 4.
Couch, **112,** 3.
Coucou de Malines, **129,** 6.
Cowslips, **112,** 4.
Cratægus Oxycantha, **147,** 1.
Cramming of poultry, **176,** 5, 6.
Cream cheeses, making of, **179.**
— Devonshire, clotted, or scalded—preparation of, **179.**
— ripening for butter making, **192,** 4.
— substitutes for calf feeding, **142,** 3, 4.
Creeping thistle, **166,** 5, 10.
Crimson clover, **182.**
Cryptococcus fagi, **140.**
Currants—useful varieties, **148,** 5.
— manuring of, **106,** 7.
Cuscuta corymbosa, **180,** 1, 2, 4.
— *Epilinum*, **180,** 1, 2, 4.
— *Epithymum*, **180,** 1, 2, 4.
— *europaea*, **180,** 1, 2, 4.
— *Gronovii*, **180,** 1, 2, 4.
— *Hassiaca*, **180,** 2.
— *major*, **180,** 2.
— *minor*, **180,** 2.
— *monogyna*, **180,** 1, 2, 4.
— *suaveolens*, **180,** 2.
— *Trifolii*, **180,** 1, 3 ; **184,** 4.
Cystopus candidus, **163.**

Dairying—cleanliness in the dairy, **151; 187,** 4.
— instruction in, **197,** 5.
Damsons—useful varieties, **148,** 5.
Dasyneura sp., **165.**
"Day old" chickens, **157.**
Dasyscypha calycina, **155.**
— *resinaria*, **155,** 4.
Destructive Insects and Pests Acts, **105,** 6; **195,** 8.
Destructor refuse—as a manure, **175,** 6.
Devonshire cream, preparation of, **179.**
Diplodia pinea, **199.**
Diseases of bees, **128,** 4.
— of cattle, **101; 102; 108; 135.**
— of sheep, **102; 119; 130; 154.**
Dock, **112,** 2.
Dodder, **180; 184,** 4, 8, 10.
Dogs Act, 1906, **190.**
— — 1871, **190,** 1.
— — Rules, **190,** 2.
Dogs Order of 1906, **190,** 1.
Dorkings, **114,** 7; **176,** 2, 3.
Draining, of land for planting fruit trees, **134,** 1.
Dried blood—as a manure, **175,** 3.
Dry rot, **113.**
Ducks and duck breeding, **167.**
Dwarf thistle, **166,** 9, 11.
Dysentery—of bees, **128,** 4.

Education, agricultural, in England and Wales, **197.**
— courses for degrees, **197,** 3.
— courses for diplomas, **197,** 3.
— dairying, instruction in, **197,** 5.
— forestry, instruction in, **197,** 6.
— grants for agricultural, **197,** 1.
— horticulture, instruction in, **197,** 5.
— notes on county work, **197,** 16.
— poultry keeping, instruction in, **197,** 6.
— short courses, **197,** 5.
Eggs—depôts, **111.**
— laying capacity of ducks, **167.**
— laying records, **129,** 2.
— preservation of, **111,** 4.
— production of, in winter, **129.**
— production of tinted, **129,** 6.
— "Rose Brand," **111,** 4.
— societies and clubs, **111.**
— testing of, **111,** 3.
Embden goose, **198,** 2.
Ensilage — use of lucerne for, **160,** 3.
English game, **114,** 7; **176,** 2, 3.
Epizootic abortion in cattle, **108.**
Exoascus deformans, **120.**

Fallows, bare, **172.**
— beneficial effects of bare, **172,** 2.
Fattening—of ducks, **167,** 10.
— of geese, **198,** 3.
— of poultry, **176.**
— cost of, for poultry, **176,** 8.
Faverolles, **129,** 2, 6; **176,** 2.
Feathers—as a fertiliser, **175,** 3.
Feeding—of chickens, **114,** 2.
— dry feeding of chickens, **114,** 2.
— of ducks, **167,** 9.
— of ducklings, **167,** 10.
— of geese, **198,** 3.
— of laying hens in winter, **129,** 4.
— of poultry, **114; 176.**
— cost of, for poultry, **114,** 6.
Feeding Stuffs and Fertilisers—Act, 1906, **196.**
— — — Regulations, 1906, **196,** 2.
Felted beech coccus, **140.**
Fences—and hedges, **147.**
— creosoted fencing, **147,** 7.
— stone walls, **147,** 7.
— wire fencing, **147,** 7.
Fertilisers, &c., *see* Manures.
Fertilisers and Feeding Stuffs—Act, 1906, **196.**
— — — Regulations, 1906, **196,** 2.
Fish, waste—as a manure, **175,** 4.
Foods, for chickens, **114,** 2.
— for ducks, **167**
— for fattening birds, **176,** 7.
— for geese, **198,** 3.
— for laying hens, **114,** 5; **129,** 4, 5.
Foot rot of sheep, **154.**
Foot-rot bath, **154,** 5–8.
Foot sore of sheep, **154,** 1.
Forestry, instruction in, **197,** 6.
Formation of permanent pastures, **168.**
Foul brood, **128,** 4.
Fruit—apple culture, **134.**
— grafting fruit trees, **162.**
— method of planting trees, **148,** 2–4.
— packing and grading of apples, **134,** 7.
— planting trees and bushes, **148.**
— pruning apple trees, **134,** 4.
— shelter belts for orchards, **148,** 7.
— storehouses for, **134,** 8.
— types of apple trees, and varieties, **134,** 3, 4.
— varieties to plant, **148,** 4.
Fumigating, box covers for, **188,** 3
— canvas covers for, **188,** 3.
— sheets for, **188,** 3.

Fumigating, tent covers for, **188,** 3.
Fungus fairy-fly, **155,** 1
Fusarium lycopersici, **116.**
Fusicladium dendriticum, **131.**
— *pirinum*, **131.**

Gall-gnats on willows and osiers, **165.**
Game, **129,** 6 ; **176,** 2, 3.
Garlic, **112,** 1.
Gas lime, **170,** 5, 6.
Geese, rearing and marketing of, **198.**
Gervais cheese, **179,** 12.
Gid, in sheep, **119.**
Golden-eye flies, **104,** 4.
Gooseberries—manuring of, **106,** 7.
— useful varieties, **148,** 5.
Gooseberry-mildew, American, **195.**
— — European, **195,** 1.
— — Order, **195,** 8.
Grafting of fruit trees, **162.**
Greaves—as a fertiliser, **175,** 3.
Green fly, **104.**
Groundsel, **112,** 2.
Gypsum, **170,** 4, 5.

Haemaphysalis punctata, **145,** 1.
Hair—as a fertiliser, **175,** 4.
Hamburgs, **129,** 2.
Hatching—of chickens, **129,** 2 ; **157,** 2.
— of ducks, **167,** 8.
— of goslings. **198,** 2, 3.
Heart rot of beet, mangold and swede, **144.**
Hedge-row timber, **156.**
Hedges, **147.**
— making of, **147.**
— weeding of, **147,** 4.
— beech, **147,** 7.
— evergreen privet, **147,** 7.
— holly, **147,** 6.
— thorn, **147,** 1.
Helicidae, **132.**
Helix aspersa, **132,** 4.
Helminthosporium gramineum, **159.**
Helophorus rugosus, **143.**
Hemiptera, **104,** 1.
Hessian, fly, **125.**
Hives, **128,** 1, 2, 3.
Holly—as a hedge plant, **147,** 6.
Honey—centrifugal extractor, **128,** 1 ; **141,** 3.
— extracting, **141,** 3.
— granulated, **141.**
— in "sections," **141.**
— "run," **141.**
Honey, packing of, **141,** 2, 3, 4.
— preparation of, for market, **141.**
Hoofs—as a fertiliser, **175,** 4.
Hop aphis, **104,** 2.
Hopper feeding of poultry, **114,** 4, 6.
Horns—as a fertiliser, **175,** 4.
Horsetails, **112,** 4.
Horticulture, instruction in, **197,** 5.
Houdans, **176,** 3.
Houses—for ducks, **167,** 8.
— for poultry, in winter, **129,** 3.
Hover flies, **104,** 4.
Hylobius abietis, **138,** 5.
Hypomyces perniciosus, **139.**

Ichneumon flies, **103,** 4 ; **125,** 2 ; **138,** 4 ; **186,** 7.
Incurvaria capitella, **123.**
Indian game, **129,** 6 ; **176,** 2.
Indian runner ducks, **167,** 4.
Industrial and Provident Societies Act, 1893, **111,** 2.
Insurance, of farming stock against fire, **189.**
— of crops and produce, **189,** 1–3.
— of implements, &c., **189,** 2–3.
— of live stock, **189,** 4.
Ixodes ricinus, **145,** 1.

Joint evil or joint ill of lambs, **130.**
Julus pulchellus—causing scab in potatoes, **137,** 4.

Lace-wing flies, **104,** 4.
Lady-birds, **104,** 4 ; **107,** 4.
Lampronia rubiella, **123,** 1.
Land Drainage Act, 1847, **181,** 1.
Langshans, **114,** 7 ; **129,** 2, 6 ; **176,** 2, 3.
Larch aphis, **155,** 1, 3.
— canker, **155.**
— sawfly, large, **186.**
— sawfly, small, **186,** 5.
Large larch sawfly, **186.**
Leather refuse—as a manure, **175,** 6.
Leghorns, **114,** 1, 7 ; **129,** 2, 6, 7 ; **176,** 3.
Lettuces, manuring of, **106,** 3.
Limacidae, **132.**
Limax agrestis, **132,** 2.
Lime, application of, **170,** 5.
— classes of, **170,** 4.
— influence of manures on, in the soil, **170,** 3.
— uses of, **170.**

Live stock, insurance of, **189,** 4.
Lophyrus pini. **103.**
— *rufus*, **103,** 3.
Lucerne, cultivation of, **160.**
Lucilia—maggot flies, **126.**
— *sericata*, **126,** 1; **145,** 2.

Machinery, precautions against accidents caused by farm, **177.**
Macrosporium solani, **164.**
— *tomato*, **164,** 1.
Malays, **129,** 6.
Mamestra brassicae, **109.**
Mange, in cattle, **135.**
Mangold, heart rot of, **144.**
Mangolds, cultivation of, **169.**
— storing of, **169,** 5.
Manures, influence on lime in the soil, **170,** 3.
Manures—fertilisers for market garden crops, **106.**
— lime, uses of, **170.**
— waste organic substances as, **175.**
Manuring—cost of, for market garden crops, **106,** 8.
— of apple trees, **134,** 2, 6.
— of mangolds, **169,** 2-4.
— of permanent pastures, **168,** 8.
— of potatoes, **173,** 7.
Marketing—of ducks, **167,** 11.
— of day-old chickens, **157.**
— of poultry, **111.**
— of geese, **198,** 3.
— of eggs, **111.**
— of honey, **141.**
Marsh thistle, **166,** 5, 10.
Meadow saffron, **112,** 1.
Medicago sativa, **160.**
Melophagus ovinus, **145,** 1.
Merulius lacrymans, **113.**
Microsphaera grossulariae, **195,** 1.
Milk, bacterial contamination of, **151,** 2.
— carriage by rail, **110.**
— importance of cleanliness in dealing with, **151.**
— records, **146; 187,** 8.
— sampling of, **146,** 3.
— substitutes—for calf feeding, **142,** 6.
— tests for farmers', **146,** 3; **187,** 8.
Milk-testing, Co-operative Societies for, **146,** 5.
Milking, **187,** 4.
— cleanliness in, **151,** 4.
— machines, experiments with, **151,** 5.
Millipedes — causing scab in potatoes, **137,** 4.
Minorcas, **129,** 2, 6, 7.
Mites, cattle mange, **135.**
Muscovy ducks, **167,** 5.
Mushroom disease, **139.**
Mussel scale, **107.**
Mutton, cross-breeding for, in the North of England, **191.**
Mytilaspis pomorum, **107.**

National Poultry Organisation Society, address of, **111,** 3.
Navel ill of lambs, **130.**
Nectria cinnabarina, **115; 183,** 2.
— *solani*, **193.**
Nematus Erichsoni, **186.**
— *laricis*, **186,** 3, 5.
— *septentrionalis*, **186,** 3.
Night-soil—as a manure, **175,** 6.
Nuts, Kentish cob, manuring of, **106,** 7.

Oats, blindness in, **159.**
Oestrus ovis, **118.**
Oidium Tuckeri, **133,** 1.
Onion mildew, **178.**
Onions, manuring of, **106,** 5.
Oospora scabies, **137.**
Organic substances as manures, **175.**
Orgyia antiqua, **161.**
Orpingtons, **129,** 2, 6, 7; **176,** 2, 3.
Ortalis fulminans, **124.**
Osiers, gall gnats on, **165.**
Oyster-shell bark louse, **107,** 4.

Paralysis—of bees, **128,** 4.
Parsnips, manuring of, **106,** 3.
Pastures, formation of permanent, **168.**
Pea beetle, **150.**
Peach leaf-curl, **120.**
Pear scab, **131.**
Pears—useful varieties, **148,** 4.
Peas, manuring of, **106,** 6.
Pekin ducks, **167,** 3.
Perennial sow thistle, **166,** 9, 12.
Peronospora Schleideni, **178.**
Peruvian ducks, **167,** 5.
Phorbia brassicæ, **122.**
Phorodon humuli, **104,** 2.
Pigsties, construction of, **121.**
Pine disease, **199.**
— sawfly, **103.**
— weevils, banded, **138.**
— weevils, large brown, **138,** 5.
Pines—species attacked by larch canker, **155,** 1.
Pissodes notatus, **138,** 1.
— *pini*, **138,** 1.

Pissodes piniphilus **138,** 1.
Plant-lice, **104.**
Planting fruit trees and bushes, **148.**
Platyparea poeciloptera, **124.**
Plums—useful varieties, **148,** 4.
— manuring of, **106,** 7.
Plymouth Rocks, **129,** 2, 6, 7; **176,** 2, 3.
Polyporus fomentarius, **113,** 4.
Pont l'Évêque cheese, **179,** 9.
Poppy, **112,** 2, 3.
Potato leaf curl, **164.**
— scabs, **137.**
— stem rot, **117.**
— winter rot of, **193.**
Potatoes—black leg of, **117.**
— black scab of **105.**
— boxing of seed, **173,** 4.
— change of seed, **173,** 2.
— corky scab of, **137,** 1.
— disease - resistant varieties, **105,** 4.
— growing in Yorkshire, **173.**
— immature seed, **173,** 3.
— manuring of, **106,** 4; **173,** 7.
— *Oospora* scab of, **137,** 1.
— Scotch, seed, **173,** 3.
— storing of seed, **173,** 4.
— useful varieties, **173,** 6.
— varieties of scab in, **137.**
— wart disease of, **105.**
Poudrette, as a manure, **175,** 6.
Poultry—ducks and duck breeding, **167.**
— fattening of, **176.**
— feeding of, **114.**
— geese, rearing and marketing of, **198.**
— instruction in poultry-keeping, **197,** 6.
— sale of newly-hatched chickens, **157.**
— societies, **111.**
Powdery mildew of the vine, **133.**
Preservation of eggs, **111,** 4.
Prevention of white scour in calves, **101.**
Privet, as a hedge plant, **147,** 7.
Propolis—on honey combs, **141,** 1, 2.
Pruning of apple trees, **134,** 4.
Pseudomonas campestris, **200.**

Quarter ill or quarter evil, **102.**

Rabbit flick, or waste—as a manure, **175,** 4.
Ragwort, **112,** 4.
Railway and Canal Traffic Act, 1854, **110,** 1.
Railway Rates and Charges Order Confirmation Acts, 1891–92, **110,** 2.
Raspberries — useful varieties, **148,** 5.
— manuring of, **106,** 7.
Raspberry moth, **123,** 1.
Rations for calves, **142,** 3.
Red clover, **184.**
Rhabdophaga sp., **165.**
Rhizoctonia violacea, **171.**
Rhizoglyphus agilis, **136,** 2.
— *echinopus*, **136.**
Rhubarb, manuring of, **106,** 4.
Rhytisma acerinum, **183.**
— *punctatum*, **183,** 2
Rose aphis, **104,** 2.
Rouen ducks, **167,** 3.
Rushes, **112,** 4.

Salix sp.—attacked by gall gnats, **165.**
Sampling—instructions for taking samples of milk, **146,** 2.
— of fertilizers and feeding stuffs, **196,** 2.
Savoys, manuring of, **106,** 2.
Sclerotinia bulborum, **127,** 2.
— *parasitica*, **127,** 2.
— *sclerotiorum*, **127.**
— *trifoliorum*, **127,** 2; **184,** 1.
Sclerotium disease, **127.**
Scottish Agricultural Organisation Society, address of, **111,** 2.
Scratching sheds, **129,** 3.
Sedges, **112,** 4.
Seeds—grass mixtures, **168,** 3.
— how to buy grass seeds, **168,** 2.
— impurities in clover seeds, **184,** 4, 7, 10.
— trifolium seed and its impurities, **182,** 5, 6.
Sewage sludge—as a manure, **175,** 7.
Sheep—black leg or quarter ill, **102.**
— cross-breeding for mutton in the North of England, **191.**
— foot rot, **154.**
— foot-sore, **154,** 1.
— ked, **145,** 1.
— lice, **145,** 1.
— maggot fly, **126; 145,** 2.
— navel ill of lambs, **130.**
— nostril fly, **118.**
— sturdy or gid, **119.**
— tick, **145,** 1.
Sheep dipping, **145.**
— — cage bath, **145,** 3.
— — hand bath, **145,** 2.
— — swim bath, **145,** 2.
— — Report of Departmental Committee, **145,** 3.

Sheep dipping, use against insect pests, &c., **126,** 3.
Sheep dips, **145,** 3.
— — composition of, **145,** 3.
— — effects on keds, lice, ticks, and maggots, **145,** 4.
— — effects on wool, **145,** 4.
Shelter belts — for orchards, **148,** 7.
Shoddy—as a manure, **175,** 5.
Shoot and fruit moth of red and black currants, **123.**
Silver fir — attacked by larch canker, **155,** 1.
Siphonophora rosæ, **104,** 2.
Slaughter-house refuse — as a manure, **175,** 4.
Sleepy disease of tomatoes, **116.**
Slug, black striped, **132,** 3.
— bulb or root-eating, **132,** 3.
— grey field, **132,** 2.
— large black, **132,** 3.
— yellow or household, **132,** 3.
Slugs and snails, **132.**
Snail, large garden, **132,** 4.
— small banded, **132,** 5.
— strawberry, **132,** 4.
— wood, **132,** 4.
Snails and slugs, **132.**
Societies—
Agricultural Organisation Society, address of, **111,** 2.
British Bee-keepers' Association, address of, **128,** 4.
National Poultry Organisation Society, address of, **111,** 3.
Scottish Agricultural Organisation Society, address of, **111,** 2.
Soils—for planting hedges **147,** 2, 6.
— influence of lime on, **170.**
— preparation for apple trees, **134,** 1.
— seeds mixture for permanent pasture on light and medium soils, **168,** 6.
— seeds mixture for permanent pasture on poor clay, **168,** 4.
— suitable for fruit growing, **148,** 1.
— suitable for lucerne, **160,** 1.
— suitable for mangolds, **169,** 1.
Sorrel, **112,** 4.
Sow thistle, annual, **166,** 9, 12.
— — perennial, **166,** 9, 12.
Spear thistle, **166,** 1, 10.
Sphaerella tabifica, **144.**
Sphaerotheca mors-uvae, **195.**
Spinach, manuring of, **106,** 3.
Spongospora scabies, **137,** 1.
Starters, preparation of, for ripening cream, **192,** 4.
Stemless thistle, **166,** 9, 11.
Stone walls, **147,** 7.
Strawberries—manuring of, **106,** 6.
— useful varieties, **148,** 6.
"Strike," in sheep, **102,** 1.
Sturdy in sheep, **119.**
Superphosphate, **106,** 7.
Sussex fowls, **114,** 7; **129,** 2; **176,** 2.
— ground oats, **198,** 3.
Swarms and hiving—of bees, **128,** 2.
Swede, heart rot of, **144.**
Sycamore leaf blotch, **183.**
Synchitrium endobioticum, **105.**
Syrphidæ, **104,** 4.

Tannery refuse—as a manure, **175,** 6.
Testacella, **132,** 3.
Tests for farmers' milk, **146.**
Thistles, **112,** 2, 3; **166.**
— extermination of, **166,** 10.
Thorn hedges—planting, weeding, cost, &c., **147,** 1-6.
Threshing of barley, **149.**
Threshing Machines Act, 1878, **177,** 1.
Timber—preservative methods, **147,** 8.
— seasoning of, for fencing, **147,** 8.
— trees in hedgerows, **156.**
Tinea capitella, **123.**
Tomatoes, bacterial disease of, **152.**
— black stripe of, **164,** 3.
— sleepy disease of, **116.**
Toulouse geese, **198,** 2.
Trap-nests, **129,** 2.
Tree root rot, **174.**
Trifolium, **182.**
Trifolium hybridum, **184,** 8.
— *incarnatum*, **182.**
— *pratense*, **184.**
— *pratense perenne*, **184,** 2;
— *repens*, **184,** 4.
Troughs—"automatic," **114,** 4.
— for fattening pens, **176,** 4.
Tubercularia vulgaris, **115,** 1.
Tulip mite, **136.**
Turnip mud-beetle, **143.**
Turnips—black rot of, **200.**
— finger and toe, **153,** 3.
— methods of storing, **153.**
Tussilago Farfara, **194.**
Tyroglyphidæ, **136.**

Uncinula spiralis, **133.**

Vapourer moth, **161.**
Vetches, **112,** 1.
Vine, powdery mildew of, **133.**
— white rot of, **158.**
Voilet root rot, **171.**

Wart disease of potatoes, **105.**
Waste organic substances as manures, **175.**
Water courses, cleansing of, **181.**
— — Land Drainage Act, 1847, **181,** 1.
Water hemlock, **112,** 1.
Weeds—and their suppression, **112.**
— bare fallows, use in eradicating weeds, **172,** 2.
— bindweed, **112,** 1, 3.
— buttercups, **112,** 4.
— charlock, **112,** 1, 3, 4.
— cleavers, **112,** 1.
— cockle, **112,** 1.
— coltsfoot, **194.**
— corn marigold, **112,** 4.
— couch, **112,** 3.
— cowslips, **112,** 4.
— creeping thistle, **112,** 3.
— dangers of, **112,** 1.
— dock, **112,** 2.
— dodder, **180; 184,** 4, 8, 10.
— garlic, **112,** 1.
— groundsel, **112,** 2.
— horsetails, **112,** 4.
Weeds—hosts for fungi, **112,** 1; **127,** 3; **159; 163,** 2; **171,** 2.
— hosts for insect pests, **112,** 1; **122,** 2.
— manner of distribution, **112,** 2.
— meadow saffron, **112,** 1.
— methods of suppression, **112,** 2.
— poppy, **112,** 2, 3.
— ragwort, **112,** 4.
— rushes, **112,** 4.
— sedges, **112,** 4.
— some common thistles, **166.**
— sorrel, **112,** 4.
— thistle, **112,** 2, 3, 4.
— vetches, **112,** 1.
— water hemlock, **112,** 1.
Weeding, of hedges, **147,** 4.
Weed seeds, found in impure clover seeds, **184,** 4, 7, 10.
— — found in impure trifolium seed, **182,** 6.
Welted thistle, **166,** 4, 10.
White clover, **184,** 4.
— English ducks, **167,** 2.
— Leghorns, **129,** 7.
— rot of the vine, **158.**
— rust of cabbages, **163.**
— scour in calves, **101.**
Willows, gall gnats on, **165.**
Windbreaks—for orchards, **134,** 2; **148,** 1.
Winter rot of potatoes, **193.**
Wyandottes, **129,** 2, 6, 7; **176,** 2, 3.
Wool, effect of sheep dips on, **145,** 4.

SPECIAL INDEX.

This index refers to insecticides, fungicides, &c.

Arsenate of lead—as an insecticide, **103,** 4; **186,** 7.
Arsenic—use against foot rot in sheep, **154,** 8.
Arsenical sprays—use in insect destruction, **161,** 3.

Bisulphide of carbon—use against insect pests, &c., **104,** 4; **122,** 4; **136,** 4; **150,** 3.
"Bluestone," *see* Copper Sulphate.
Bordeaux mixture—as a fungicide, **120,** 3; **131,** 2; **185,** 2; **195,** 6.

Carbolic acid—as a fungicide, **116,** 2.
— — for disinfecting, **102,** 2; **108,** 4; **135,** 2.
— — use against abortion, **108,** 3.
— — use against insect pests, &c., **122,** 4.
Carbon bisulphide, *see* Bisulphide of Carbon.
Caustic alkali wash, **134,** 6.
Caustic soda in spraying mixtures, **140,** 4.
— — use against insect pests, &c., **132,** 5; **134,** 6.
— — spray, **104,** 3.
Caustic-soda-emulsion—use against insect pests, &c., **107,** 3; **123,** 3.
Charcoal, powdered—use against asparagus fly, **124,** 2.
Coke, powdered—use against slugs and snails, **132,** 5.
Copper sulphate—as a fungicide, **131,** 2; **133,** 2; **139,** 3; **158,** 2; **159,** 2; **195,** 4–6.
— — destroying charlock, **112,** 4.
— — for disinfecting cowhouses, **101.**
— — use against foot rot in sheep, **154,** 7.
Corrosive sublimate—as a fungicide, **113,** 2; **200,** 2.
—use against abortion, **108,** 4.
Creosote—use against dry rot, **113,** 2.

Emulsion-soda wash, **104,** 3; **107,** 3; **123,** 3; **140,** 4.

Fish oil—use against sheep nostril fly, **118,** 3.
Formalin—as a fungicide, **137,** 1; **159,** 2; **200,** 2.
Fumigating, *see* Bisulphide of Carbon and Hydrocyanic Acid Gas.

Gas-lime—as a fungicide, **105,** 2, 4; **116,** 2; **127,** 3.
— use against insect pests, &c., **109,** 3; **132,** 6.

Hellebore wash—as an insecticide, **103,** 4; **186,** 7.
Hydrocyanic acid gas—fumigation with, **107,** 3; **188.**

Iodine—use against white scour in calves, **101,** 1.

Kainit—as a fungicide, **164,** 3; **193,** 2.

Lead arsenate, *see* Arsenate of Lead.
Lime—as a disinfectant, **130,** 2.
— as a fungicide, **116,** 2; **127,** 3; **171,** 2; **174,** 3; **178,** 2; **193,** 2.
Lime, use against insect pests, &c., **104,** 3; **132,** 5; **140,** 4.
Linseed oil—use against cattle mange, **135,** 2.
Liver of sulphur—as a fungicide, **195,** 4–7.
— use against insect pests, &c., **136,** 3.
Lysol—use against white scour in calves, **101,** 1.

Paraffin—use against insect pests, &c., **122,** 4 ; **126,** 3 ; **132,** 6 ; **136,** 3.
Paraffin emulsion, **104,** 3 ; **107,** 3 ; **123,** 3 ; **140,** 4 ; **155,** 3.
— — and soda-wash, **104,** 3 ; **140,** 4.
Paris green—as an insecticide, **161,** 3 ; **186,** 7.
Permanganate of potash—as a fungicide, **158,** 2.
Potassium cyanide—use in fumigation, **188,** 1.
Potassium sulphide—as a fungicide, **133,** 1 ; **185,** 2.
— — use against bulb mite, **136,** 3.

Quassia—use against insect pests, &c., **104,** 3.
Quicklime, *see* Lime.

Rape oil—use against sheep maggot fly, **126,** 3.

Salt—use against insect pests, &c. **132,** 5.
Soda, *see* Washing soda.
Soda-emulsion wash, **104,** 3 ; **107,** 3 ; **123,** 3 ; **140,** 4.
Soft soap—use against insect pests, &c., **104,** 3 ; **122,** 4 ; **134,** 6.
Soot—use against insect pests, &c., **132,** 5.
Spirit of tar—use against insect pests, &c., **126,** 3 ; **135,** 2.
Sulphate of copper, *see* Copper sulphate.
Sulphate of iron—for destroying charlock, **112,** 4.
— for destroying dodder, **180,** 6.
— for spraying, **104,** 3 ; **123,** 3 ; **140,** 4.
— *see also* Copperas.
Sulphide of potassium—*see* Potassium sulphide.
Sulphur—as a fungicide, **105,** 2, 4 ; **137,** 2 ; **174,** 3 ; **178,** 2 ; **193,** 2.
— in sheep dips, **126,** 3.
— use against insect pests, &c., **126,** 3 ; **135,** 2.
Sulphuric acid—use against foot rot in sheep, **154,** 8.
— use in fumigation, **188,** 1.

Tar—for protecting wounds on trees, **115,** 2 ; **174,** 3.
— use against navel ill, **130,** 2.
— use against insect pests, &c., **118,** 3 ; **132,** 6.
— use against white scour in calves, **101,** 1.
Turpentine—use against sheep maggot fly, **126,** 3.

Washing soda—use against foot rot in sheep, **154,** 8.
Woburn wash, **104,** 3 ; **107,** 3 ; **123,** 3 ; **140,** 4.

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† (N.B.—These Diagrams can only be obtained, either directly or through any bookseller, from Wyman & Sons, Limited, Fetter Lane, London E.C. ; Oliver & Boyd, Edinburgh ; E. Ponsonby, 116 Grafton Street, Dublin.)

BOARD OF AGRICULTURE AND FISHERIES.

British Breeds of Live Stock.

With a view to the encouragement of the exportation of live stock, the Board of Agriculture and Fisheries caused a Handbook, descriptive of the principal breeds of British Live Stock, to be prepared for the information of foreign agriculturists visiting the Brussels and Buenos Aires International Exhibitions of 1910. This Handbook has now been placed on sale in this country, and will probably be found to be of service to all who are interested in the breeding of live stock, whether for exportation or otherwise.

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